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STATUS OF HUMAN RESOURCES: IMPLICATIONS FOR THE IMPLEMENTATION OF UPPER BASIC OF THE UNIVERSAL BASIC EDUCATION (UBE) PROGRAMME IN BAYELSA STATE OF NIGERIA

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Abstract. This study investigates the status of human resources in Bayelsa State of Nigeria and its implications for the implementation of upper basic of the Universal Basic Education (UBE) programme. A total of 181 teachers were involved in the study. The results of the study show that there are qualified human resources for the implementation of upper basic of the UBE programme in Bayelsa State of Nigeria but they are inadequate in all the three basic subjects (English Language, Mathematics and Integrated Science). Also, there is no significant difference in the availability and adequacy of human resources in the three subjects. It is recommended that adequate human resources should be provided by the government for effective teaching and implementation of the UBE programme.

Keywords: human resources, Universal Basic Education (UBE), implementation

Introduction

Education is so basic to nation-building that nations all over the world strive to make it available not only to the few that can afford it but to all citizens.[1] Nigeria has sought national development by using education to attain desired national objectives. Hence, according to Sanni & Ogonor,[2] the Federal Government of Nigeria evolved the Universal Primary Education (UPE) in 1976 and the Universal Basic Education (UBE) scheme in May, 1999. The non-realization of the objectives of the Universal Primary Education Scheme with the world wide emphasis on basic education necessitated the evolution of the proposed Universal Basic Education Scheme[2].

The non realization of the objectives of UPE was due to a lot of factors. According to Nduka[3] some of the primary objectives of the revised 1981 National Policy on Education are more likely to be achieved at the junior secondary level than the end of the six year primary school level. Hence, the collapse of the 1976 UPE scheme was an evidence of the deficiency of the programme. Nduka went further to say that the new thinking was therefore a compulsory basic education programme including the junior secondary education segment.

The failure of the UPE was not only a result of the revision of the 1977 National Policy on Education. According to Obanya[4] a lot of other factors hindered the achievement of the objectives of the UPE scheme; among which are teachers' recruitment, education, retraining and motivation, data collection and analysis, infrastructural facilities, textbooks and instructional materials and funding. However, Obanya further mentioned that the Federal Government, in order to make vigorous efforts to counter the factors which hindered the achievement of the goals of the UPE scheme, introduced the UBE scheme. The UBE scheme in achieving this purpose would modify the behaviour of the individual in order to cope and adapt to the demand of his/her environment (Ehigie & Amayo, 1999).

The new UBE consists of three basic levels: the first level (lower basic) is the first three years in primary school; the second level (middle basic) is the 4^{th} – 6^{th} years in primary school and the third level (upper basic) is the 7^{th} – 9^{th} years in primary school. The junior secondary school is now called the Upper Basic.[5)]

The wealth and vitality of a nation rest ultimately upon the development of their people and upon the effective commitment of human energies and talents. Without human resources teaching and learning will not take place effectively, especially in Science, Technology and Mathematics (STM), where the teachers must always be around to guide and direct students in the learning process.[6)] The teacher holds the key to meaningful education which is vital to nation building; consequently any nation desirous of transformation into a great country must be committed to making teachers available to meet the requirement of the school system (Sotonwa, 2003).

If the language, generally accepted by the people for official and unofficial purposes is well harnessed, the nation in which it is used definitely must experience development (Ekah, 2004). Hence, English Language is made compulsory at primary, secondary and first year in the university as a General Study course. However, English Language has not received the serious attention in Nigeria despite its crucial importance for the country and, therefore, the subject is not properly taught in our schools. Affirming this Eyoh (2004) stated it is no secret that graduates and non-graduates in subjects other than English teach English language at our primary and secondary school stages of education where the foundation for effective performance in the language is supposed to be laid.

Science plays a major role in all human activities ranging from everyday living in order to cope and adapt to the demands of the environment. Ige & Arowolo (2003) opined that science will continue to play an increasingly

important role in every individual's life whether the individual may have chosen science profession or not, hence the government through its science education programme focuses on achieving the goal of "science for all" (Nworgu, 2005). According to Nworgu (2005) the government has demonstrated commitment to the inculcation of scientific literacy among all Nigerians not only for those pursuing scientific careers or profession through making science compulsory (a core subject) to our primary and junior secondary schools. However, the problem of not having enough manpower would always exist because of the tradition of lack of adequate motivation and provisions to study science and technology in our educational system (Ajewole, 2005).

Integrated Science was introduced into Nigerian secondary schools as a panacea for all the problems bedeviling science especially at the junior secondary school level (Emeka & Odetoyinbo, 2003). The teaching of the subject requires the provision of adequate and appropriate materials to be handled by specialists in the subject. Ige & Arowolo (2003) stated that lack of adequate materials for practical activities and specialist teachers of Integrated Science were factors that hindered the acquisition of science process skills by students in the junior secondary schools. Supporting this view, Abba & Ubandoma,[7)] citing Bajah, stated that lack of well-trained personnel was identified as a key factor constraining the effective implementation of Integrated Science curriculum. Among the major reasons identified was the inefficiency of human resources capacity, hence the need for capacity building, including education and training and information management.

Mathematics is seen as a precious and an indispensable tool used by scientists, thus, it should be seen as central in the teaching of science (Arigbabu & Oludipe, 2004). Hence, the subject is made compulsory for all students in junior secondary school. The teaching of Mathematics effectively is being hindered by a lot of factors. According to Obodo (2004), the factors among others include attitude of students, lack of Mathematics teachers, poor

students' background in Mathematics and lack of Mathematics laboratory. The lack of Mathematics teachers has always been one of the major factors responsible for the effective teaching of Mathematics. Hence, it has been showed that the shortage of qualified Mathematics teachers exerts considerable influence on students' learning outcome in Mathematics (Obodo, 2004). This according to Obodo is as a result of non-professionals teaching the subject who lack necessary elementary principles and practice of education knowledge.

The UBE programme is similar to the UPE programme and needs to derive its lesson from the failure of UPE programme. Madugu (2000) stated that the UPE programme failed as a result of inadequate supply of trained teachers, improper compilation of and unreliable statistical data thereby resulting into wrong projection, financial shortage, poor publicity, and lack of involvement of those concerned. Idehen & Izevbigie[8)] posited that the implementation stage of any educational programme contends with practical obstacles which make it impossible for the actualization of intended goals and objectives. They further stated that problems such as shortage of teachers, absence of suitable textbooks, absence of necessary equipment, insufficient funds, poor organizational abilities, effective management and supervision may adversely affect the successful implementation of the UBE programme.

The role played by teachers in any educational system is enormous. They are responsible for the translation and implementation of educational policies and curriculum and all-round achievement of the child. This is why the National Policy on Education stated that no education can rise above the quality of its teachers. The implementation of the upper basic of the UBE therefore lies with the teachers. Therefore, their qualification should be examined in order to check their abilities to implement the programme successfully.

Purpose of the study

The purpose of this study is to determine the status of English Language, Mathematics and Integrated Science teachers in the upper basic of the UBE programme. The study is designed to achieve the following objectives: (1) to determine the availability of qualified human resources in the teaching of English Language, Mathematics and Integrated Science; (2) to determine the adequacy of available qualified human resources in the teaching of English Language, Mathematics and Integrated Science.

Research hypotheses

H_o1: There is no significant difference between the availability of qualified number of human resources for the teaching of English Language, Mathematics and Integrated Science and those not qualified.

H_o2: There is no significant difference in the adequacy of available human resources for the teaching of English Language, Mathematics and Integrated Science.

Research method

The survey design was used for this study. The population of the study consisted of all the 427 upper basic schools teachers of English Language, Mathematics and Integrated Science in Bayelsa State of Nigeria. The stratified sampling technique was used in obtaining 41% of the upper basic schools from each of the 12 educational zones in Bayelsa State of Nigeria. A total of 60 upper basic schools were randomly selected from the 148 upper basic schools. A total of 181 teachers were involved in the study of which 69 were English Language teachers, 75 were Mathematics teachers and 37 were Integrated Science teachers.

Teachers were classified into two, namely qualified and non-qualified teachers. Qualified teachers possess the Nigerian Certificate of Education

(NCE), or Bachelor of Art Education (BAEd)/Bachelor of Science Education (BScEd), or Bachelor of Art (BA)/ Bachelor of Science (BSc) plus Post Graduate Diploma in Education (PGDE) in English Language, Mathematics and Integrated Science. Non-qualified teachers are those without teaching qualifications and those with teaching qualifications but are teaching subjects that are not in their area of specialization.

A structured questionnaire for teachers tagged Availability and Adequacy of Human Resources for Teaching English Language, Mathematics and Integrated Science (AAHRTEMI) was used for the study. It consisted of two sections: Section one contained demographic data such as name of school, experience, qualification and area of specialization. Section two contained the subjects and the column for adequate and not adequate, where the teacher is expected to tick whether in his school and area of specialization teachers are adequate or not.

The instrument was validated by three specialists, one from each of the subject areas. The instrument was trial-tested using 45 teachers (15 teachers from each of the subject areas) who were not part of the main study but had the same qualities as those used in the main study. A test-retest approach using Pearson Product Moment Correlation (PPMC) was used to establish the reliability. The reliability coefficient of the instrument was 0.81.

The questionnaire was administered by the researcher to the respondents and the completed copies of the questionnaire were used to generate data for the study. Data analysis involved the use of frequency count, percentage and Chi-square.

Results and discussion

Are the available human resources qualified and adequate for the teaching of English Language?

Table 1. Frequency distribution and percentage of availability and adequacy of English Language teachers

	Qualification	Number of teachers (English)	Q	NQ	A	NA
1	NCE (English)	38	38/55%		10/15%	28/41%
2	NCE (teaching English)	21		21/30%	2/3%	19/28%
3	BAEd/BEd English	5	5/7%		2/3%	3/4%
4	BAEd/BEd (other areas)	3				3/4%
5	BA/HND	2		2/3%	½%	1/2%
	Total	69	43/62%	26/38%	15/22%	54/78%

Q=qualified; NQ=not-qualified; A-adequate; NA=not-adequate
NCE=Nigerian Certificate of Education
BA=Bachelor of Art
BAEd=Bachelor of Art Education
BEd=Bachelor of Education
HND=Higher National Diploma

Table 1 shows the frequency and percentage of qualified and adequate English Language teachers. The table shows that 55% of English Language teachers are NCE teachers that read English Language; 30% are NCE teachers that did not read English Language but teach English Language; 7% are BAEd./BEd teachers that read English Language, 4% are BAEd./BEd teachers that did not specialize in English Language but are teaching English Language and 3% are BA/HND teachers without teaching qualification. The Table 1 shows also the responses of teachers having indicated the adequacy and inadequacy of English Language teachers in their schools. 15% of NCE teachers that read English Language indicated adequate while 41% indicated not adequate; 3% of NCE teachers that did not read English Language but are teaching English Language indicated adequate while 28% indicated not adequate; 3% of English Language teachers that have BAEd./BEd indicated adequate while 4% indicated not adequate; Non-English Language teachers that have BAEd./BEd indicated not adequate while none indicated adequate and 2% of BA/HND teachers indicated adequate while 2% indicated not adequate.

The Table 1 thus indicates that 62% of the English Language teachers are qualified while 37.68% of the English Language teachers are not qualified. Also, 21.74% of the respondent indicated the available English Language teachers are adequate while 78.26% indicated that the number of available English Language teachers is inadequate. This implies that there is shortage of qualified English Language teachers for the implementation of the Universal Basic Education (UBE) Programme in Bayelsa State of Nigeria. This is in line with Omoh[9)] who found the alarming deficiency in teacher – student ratio as a result of teachers' supply not meeting teachers' demand in Federal Capital Territory (FCT), Abuja resulting in expected corresponding large class size existence.

Are the available human resources qualified and adequate for the teaching of Mathematics?

Table 2 shows the frequency and percentage of qualified and adequate Mathematics teachers. The table shows that Mathematics teachers consisted of NCE that read Mathematics are 53%; NCE that did not read Mathematics - 17%; BScEd./BEd that read Mathematics - 15%; BSc (Mathematics) with PGDE 7% and BSc/HND 8%. The Table also shows the responses of teachers having indicated the adequacy and inadequacy of Mathematics teachers in their schools. 11% of the teachers that read NCE Mathematics indicated adequate while 43% indicated not adequate; 4% of NCE teachers that did not read Mathematics indicated adequate while 13% indicated not adequate; 3% of BScEd/BEd Mathematics teachers indicated adequate while 12% indicated not adequate; 1% of BSc Mathematics teachers with PGDE indicated adequate and 5% indicated not adequate and finally 3% of BSc/HND holders indicated adequate while 5% indicated not adequate.

Table 2. Frequency distribution and percentage of availability and adequacy of Mathematics teachers

	Qualification	Number of teachers (English)	Q	NQ	A	NA
1	NCE (Mathematics)	40	40/53%		8/11%	32/43%
2	NCE (non Math)	13		13/17%	¾%	10/13%
3	BAEd/BEd Math	11	11/15%		2/3%	9/12%
4	BSc with PGDE	5	5/7			3/4%
5	BSc/HND	6		6/8%	2/3%	4/5%
	Total	75	56/75%	19/25%	16/21%	59/79%

Q=qualified; NQ=not-qualified; A-adequate; NA=not-adequate
NCE=Nigerian Certificate of Education
BAEd=Bachelor of Art Education
BEd=Bachelor of Education
HND=Higher National Diploma
PGDE=Post Graduate Diploma in Education

The Table thus indicated that 75% of Mathematics teachers are qualified while 25% are not qualified. Also, 21% of the respondents indicated that the available Mathematics teachers are adequate while 79% indicated that the number of available Mathematics teachers is inadequate. This implies that there is shortage of qualified Mathematics teachers for the implementation of the UBE Programme in Bayelsa State of Nigeria. The 79% of teachers that indicated shortage of teachers is in line with Obodo (2004) who reported that the shortage of qualified Mathematics teachers exerts considerable influence on students' learning outcomes in Mathematics.

Are the available human resources qualified and adequate for the teaching of Integrated Science?

Table 3. Frequency distribution and percentage of availability and adequacy of Integrated Science teachers

	Qualification	Number of teachers (English)	Q	NQ	A	NA
1	NCE (Science)	21	21/57%		8/22%	13/35%
2	NCE (non Science)	12		12/32%	5/14%	7/19%
3	BScEd/BEd Science	-	-	-	-	-
4	BScEd/BEd non Science	3	-	3/8%	-	3/8%
5	BSc/HND	1	-	1/3%	-	1/3%
	Total	37	21/57%	16/43%	13/35%	24/65%

Q=qualified; NQ=not-qualified; A-adequate; NA=not-adequate
NCE=Nigerian Certificate of Education
BA=Bachelor of Art
BAEd=Bachelor of Art Education
BEd=Bachelor of Education
HND=Higher National Diploma
PGDE=Post Graduate Diploma in Education

Table 3 shows the frequency and percentage of qualified and adequate Integrated Science teachers. The table shows that Integrated Science teachers consisted of 57% of NCE teachers that read Integrated Science; 32% of NCE teachers that read other sciences; 8% of BScEd/BEd that read other sciences and 3% of BSc/HND teachers in terms of their qualifications. The Table also shows the responses of teachers having indicated the adequacy and inadequacy of Integrated Science teachers in their schools. 22% of NCE teachers that read Integrated Science indicated adequate while 35% indicated not adequate; 14% of NCE teachers that read other sciences indicated adequate while 19% indicated not adequate; 8% of holders of BScEd/BEd in other sciences indicated not adequate while none indicated adequate and 3% of holders of BSc/HND indicated not adequate while none indicated adequate.

The Table thus indicated that 57% of the Integrated Science teachers are qualified while 43% of the Integrated Science teachers are not qualified. Also, 35% of the respondents indicated that the available Integrated Science

teachers are adequate while 65% indicated that the numbers of available Integrated Science teachers are inadequate. This implies that there is shortage of qualified Integrated Science teachers for the implementation of the UBE programme in Bayelsa State of Nigeria.This agrees with Ajewole (2005) that serious shortfalls have always existed in the number of professionally qualified science and technical teachers needed in the nation's schools and colleges.

Hypothesis one

There is no significant difference between the availability of qualified number of human resources for the teaching of English Language, Mathematics and Integrated Science and those not qualified.

Table 4. Chi-square analysis of the availability of human resources

Qualification	ENG	MATH	SCI	total	Df	Chi/cal	Chi/cr	Decision at p<.05
Qualified	43/46%	56/50%	21/25%	120	2	4.36	5.99	NS
Not qualified	26/33%	19/25%	16/13%	61				
total	69	75	37	181				

ENG=English Language
MATH=Mathematics
SCI= Integrated Science
NS=Not Significant at p<.05 alpha level

As shown in Table 4, the calculated Chi-square value of 4.36 is less than the critical Chi-square value of 5.99. Thus, the null hypothesis stating a non significant difference between the availability of qualified number of human resources for the teaching of English Language, Mathematics and Integrated Science and those not qualified was retained. This implies that the number of qualified teachers available to teach in the upper basic is not significantly higher than those not qualified. This is in line with Eyoh (2004) who stated that it is no secret that graduates and non-graduates in subjects other than English Language teach English Language at our primary and sec-

ondary school stages of education. It is also in line with Abba & Ubandoma[7)]who stated that untrained personnel was identified as a key factor constraining the effective implementation of Integrated Science curriculum.

Hypothesis two

There is no significant difference in the adequacy of available human resources for the teaching of English Language, Mathematics and Integrated Science.

Table 5. Chi square analysis of the adequacy of human resources available

Qualification	ENG	MATH	SCI	total	Df	Chi/cal	Chi/cr	Decision at p<.05
Qualified	15/17%	16/18%	13/9%	44	2	2.97	5.99	NS
Not qualified	54/52%	58/57%	24/28%	137				
total	69	75	37	181				

ENG=English Language
MATH=Mathematics
SCI= Integrated Science
NS=Not Significant at p<.05 alpha level

As shown in Table 5, the calculated Chi-square value of 2.97 is less than the critical Chi-square-value of 5.99. Thus, the null hypothesis stating a non significant difference in the adequacy of available human resources for the teaching of English Language, Mathematics and Integrated Science was retained. This implies that there exists an insignificant difference in the adequacy of available human resources for the teaching of English Language, Mathematics and Integrated Science.

Conclusion

From the findings of the study, there is a clear indication that there are more qualified human resources when compared to the non-qualified human resources but are inadequate in all the three subjects. Also, there exists no sig-

nificant difference in the availability and adequacy of human resources for the teaching in the three subjects.

Recommendations

1. Adequate human resources for all the three subjects (English Language, Mathematics and Integrated Science) should be recruited by government.

2. BSc/HND teachers without teaching qualifications should be encouraged to go for in-service training in order to make them qualified to teach the subjects.

3. The teaching profession should be made attractive to invite others to the profession and retain the existing teachers in the classroom by giving special allowances to professional teachers.

4. Seminars, conferences and workshops should be organized for school principals and teachers in secondary schools on the need for maximum usage of the available human resources.

NOTES

1. Odo, C.O. (2000). Towards enhancing the success of the universal basic education (UBE) scheme. In.: *15th Annual Conference Proceedings of Nigerian Academy of Education (NAE),* pp. 112-114.

2. Sanni, G.A., Ogonor, B.O. (2000). Universal basic education scheme in Nigeria: Management for goal attainment. In.: *15th Annual Conference Proceedings of Nigerian Academy of Education (NAE),* pp. 172-181.

3. Nduka, O. (2000). Meaning, purpose and content of universal basic education programme. In.: *15th Annual Conference Proceedings of Nigerian Academy of Education (NAE),* pp. 27-31.

4. Obanya, P.A.I. (2000). Federal Republic of Nigeria implementation guideness for the universal basic education programme. In.: *15th Annual Conference Proceedings of Nigerian Academy of Education (NAE),* pp. 10-16.

5. *Manual for the re-training of primary school teachers: school based assessment.* National Teachers' Institute, Kaduna, 2006.

6. Nkwocha, L.U. (1998). The state of resources for communicating STM in secondary schools in Niger state. A paper presented at the 39th Annual Conference of Science Teachers Association of Nigeria (STAN), pp. 65-69.

7. Abba, I. & Ubandoma, Y. (2006). Human resources development model for integrated science. *Proceedings of the 47th Annual Conference of Science Teachers Association of Nigeria (STAN),* pp. 227-231.

8. Idehen, C.O. & Izevbigie, T.I. (2000). Implementation of the universal basic education programme: The way forward. In.: *15th Annual Conference Proceedings of Nigerian Academy of Education (NAE),* pp. 192-200.

9. Omoh, D.O.K. (2006). Implication of human resources demand and supply on primary education in FCT. *Proceedings of the 47th Annual Conference of Science Teachers Association of Nigeria (STAN),* pp. 50-52.

REFERENCES

Ajewole, A.G. (2005). Science and technology education in secondary schools: Need for manpower development. *J. Science Teachers Association Nigeria, 40,* 63-67.

Arigbabu, A.A. & Oludipe, D.I. (2004). Relationship between prior mathematics knowledge and students' academic performance in integrated science. *J. Science Teachers Association Nigeria, 39,* 52-55.

Eyoh, L. (2004). The future of the English language in Nigeria in the context of globalization. *J. Nigerian English & Literature, 5,* 32-42.

Enigie, J.O. & Amayo, O.R. (1999). *The teaching and practice of philosophy of education.* Benin City: Chosen Publications.

Ekah, M.E. (2004). Globalization, second language and national development. *J. Nigerian English & Literature, 5,* 56-69.

Emeka, A.E. & Odetoyinbo, B.B. (2003). Teachers factors as determinants of achievement in integrated science. *J. Science Teachers Association Nigeria, 36,* 94-99.

Ige, T.A. & Arowolo, J.G. (2003). Effect of hypothetic – deductive approach on J.S.S. III students' achievement in integrated science. *J. Science Teachers Association Nigeria, 38,* 39-45.

Madugu, J.E. (2000). From UPE to UBE in Nigeria. *J. Education Studies Institute Education, 6,* 68-77.

Nworgu, L.N. (2005). Effect of gender sensitization package on students' achievement in integrated science. *J. Science Teachers Association Nigeria, 40,*74-79.

Obodo, C. (2004). *Principles and practice of mathematics education in Nigeria.* Enugu: Academic Forum.

Sotonwa, O.O. (2003). Quality teachers and quality teaching: Towards achieving quality universal basic education. *Nigerian J. Education Research & Evaluation, 4,* 69-78.

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A CONFIRMATORY FACTOR ANALYSIS ON THE ATTITUDE SCALE OF CONSTRUCTIVIST APPROACH FOR SCIENCE TEACHERS

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Abstract. Underlining the importance of teachers for the constructivist approach, the present study attempts to develop "Attitude Scale of Constructivist Approach for Science Teachers (ASCAST)". The pre-applications of the scale were administered to a total of 210 science teachers; however, the data obtained from 5 teachers were excluded from the analysis. As a result of the analysis of the data obtained from the pre-applications, it was found that the scale could have a single factor structure, which was tested using the confirmatory factor analysis. As a result of the initial confirmatory factor analysis, the values of fit were examined and found to be low. Subsequently, by examining the modification indices, error covariance was added between items 23 and 24 and the model was tested once again. The added error covariance led to a significant improvement in the model, producing values of fit suitable for limit values. Thus, it was concluded that the scale could be employed with a single factor. The explained variance value for the scale developed with a sin-

gle factor structure was calculated to be 50.43% and its reliability was found to be .93. The results obtained suggest that the scale possesses reliable-valid characteristics and could be used in further studies.

Keywords: constructivist approach, science and technology teachers, confirmatory factor analysis

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Introduction

Instead of the behaviorist approach which considers the minds of students as blank slates and reserves for teachers the role of transmitting knowledge, contemporary learning environments are now increasingly being dominated by the constructivist approach which maintains that students filter through mental processes and structure new information on the basis of their previous knowledge and experiences through an active participation in the process. Although interpretations of the constructivist approach do differ according to varying perspectives, in the most general sense it rests upon the underlying argument that students structure new information on their previous knowledge through the social and cognitive processes they actively participate in, and learn by establishing mental relationships among the information in question. The approach assigns an active role to students in learning process, while teachers abandon the role of transmitting knowledge and assume the role of guiding students in structuring knowledge and facilitating the process. To put it differently, teachers are entrusted with facilitating the learning of students, helping them have access to information, guiding them, and controlling their learning process as a whole. Thus, by student-centered education one should not assume that teachers have now reduced roles. On the contrary, teachers are supposed to be more investigative in the constructivist approach (Köseoğlu & Kavak, 2001). This requires that teachers assume a very active role in learning environments in which the constructivist approach is used

(Selley, 1999). In this approach, teachers are charged with crucial responsibilities such as revealing the previous knowledge of students, providing them with appropriate learning environments, encouraging them to test their ideas and compare them with scientific knowledge, and helping them get into interaction with people and sources of information (Watts et al.,1997; Bağcı-Kılıç, 2001).

Therefore, teachers take a crucial part in helping student structure new information on the basis of their previous knowledge (Watson, 2001). Given the qualities that teachers need to possess, in constructivist learning environments, it is evident that teachers are not to undertake a passive role, but on the contrary are supposed to dominate the process in many respects. Therefore, classroom environments organized in line with the constructivist approach place greater duties and responsibilities on teachers. According to Rosenfeld & Rosenfeld (2006), in creating classroom environments based on the constructivist approach, teacher opinions concerning the difficulties with creating such environments are of considerable importance. Thus, it could be suggested that affective attributes are among the principal components that affect teachers' performance of their duties and responsibilities. It is believed that one of these affective attributes is teacher attitudes toward the constructivist approach.

Taking into consideration the importance of teachers in creating learning environments based on the constructivist approach which recently gained prominence in science and technology instruction, the study was dedicated to developing the scale in question. To Tezbaşaran (1997), attitude refers to the tendency to display positive or negative learned reactions towards a certain object, situation, institution, concept or person. Therefore, the study aims to develop a scale that could be used to identify and assess the attitudes of science and technology teachers towards the constructivist approach. A review of the relevant literature did not reveal any study on scale development intended

to identify the attitudes of science and technology teachers towards the constructivist approach, which was the motive for conducting the present study.

Method and participants

The study is concerned with developing a scale. The pre-applications at the development stage of the ASCAST were carried out with Science Teachers exercising the teaching profession in cities randomly selected from seven geographical regions of Turkey, 30 teachers from each region. However, five teachers were excluded from the research as they left most of the scale items blank. Thus, the analyses were based on the responses of 205 teachers to the pre-application form. In the view of Harrington (2009), although researchers agree that greater samples yield better results for confirmatory factor analysis, there is no consensus as to which sample size would be sufficient. Kelloway (1998) suggests that pre-applications with 200 observations usually constitute a suitable threshold for sample size. Concerning sample size, Kline (1998), on the other hand, refers to sample sizes lower than 100 as small, those between 100 and 200 as medium and those higher than 300 as large samples. Furthermore, Kline (1998) argues that the statistical invariance of the results could be precarious if the respondent/variable ratio is lower than 5/1, while the same ratio is lower than 3/1 according to Harvey et al. (2005). While relatively smaller samples may well suffice under certain conditions, other conditions might require extremely large samples for factor analysis (MacCallum et al., 1999). Consequently, given the literature in question and the studies conducted, the pre-application sample could be considered to be at a sufficient level.

The study also considered the voluntariness of teachers in participating in the research. The demographic characteristics of the participant prospective teachers are as follows: (a) 4.9% (n=10) of the teachers are in the age range of 20-25, 17.6% (n=36) in the age range of 26-30, 23.4% (n=48) in the age range

of 31-35, 22.9% (n=47) in the age range of 36-40 and 31.2% (n=64) are of 41 years of age or above; (b) 31.2% (n=64) of the teachers are male, and 68.8% (n=141) are female. Furthermore, 13.2% (n=27) of the teachers stated that they have professional experience of 1 to 5 years, 24.4% (n=50) 6 to 10 years, 35.6% (n=73) 11 to 15 years, 13.7% (n=28) 16 to 20 years, 2.4% (n=5) 21 to 25 years, 10.7% (n=22) 26 years and above; (c) 55.6% (n=114) of the teachers stated that they are graduates of faculties of education, 30.7% (n=63) of colleges, 0.6% (n=1) of the faculty of letters, 10.2% (n=21) of the institutes of education, while 2.9% (n=6) marked the option "other"; (d) 1.5% (n=3) of the participant teachers stated that they are holders of two-year program degrees, 87.8% (n=180) of undergraduate degrees, 8.8% (n=18) of master degrees and 0.5% (n=1) of PhD degrees, while 1.5% (n=3) marked the option "other".

An examination of the participating teachers' responses to the demographic characteristics question about graduation fields revealed that 25.9% (n=53) of the teachers held diplomas in the field of science, %18.5 (n=38) in Physics, 25.4% (n=52) in Chemistry, 20.5% (n=42) in Biology, and 9.8% (n=20) in other fields.

Results and interpretation

This section of the study deals with the processes of validity, reliability, and item analyses on the "Attitude Scale of Constructivist Approach for Science and Technology Teachers". For analysis, SPSS 12 and LISREL 8.51 were used.

Generating the item pool and obtaining expert opinion

The process of generating an item pool for the scale made use of the study on attitude scale development for prospective teachers, which was conducted in parallel to the research, the interviews with the teachers, and relevant studies on scale development (Berberoğlu, 1990; Ekici, 2002; Nuhoğlu &

Yalçın, 2004; Kan & Akbaş, 2005; Çetin, 2006). Ten open-ended questions about the constructivist approach were addressed to the prospective teachers to identify the scale items and some items were added to the scale in accordance with prospective teachers' responses. Furthermore, some other items were also added to the scale on the basis of teachers' opinions about applications on the constructivist approach and their use in science instruction, which were obtained through semi-structured interviews with teachers in the workshops performed under a TUBITAK project. Finally, the attitude items obtained from the relevant literature were adjusted to the constructivist approach and included in the scale. Subsequently, five expert instructors and two Science and Technology Teachers were asked to state their opinions about 80 items in the scale. On the basis of expert opinion, the scale items were subjected to necessary arrangements and 41 items were removed from the scale in accordance with experts' suggestions on the ground that they did not assess attitude.

Exploratory and confirmatory factor analysis

The first analyses following the pre-applications of the scale attempted to ensure structure validity for the scale. Therefore, exploratory factor analysis was first performed, which was followed by confirmatory factor analysis to test the validity of the structure obtained from the exploratory factor analysis. Exploratory factor analysis is used to identify the latent variables or factors of priority for a set of variables (Harrington, 2009). Confirmatory factor analysis mainly aims to test the fit of a model obtained from exploratory factor analysis or a previously existing theoretical model with the data obtained from a given sample. Factor analysis requires a normal distribution in the universe (Tavşancıl, 2005). To the view of Şencan (2005), multivariate normal distribution of variables is particularly important if the "maximum likelihood" method is used; yet, principal component analysis and common component

analysis do not involve an assumption directly related to distribution. Kelloway (1998) and Harrington (2009) suggests that one precondition for the "maximum likelihood" method particularly used in confirmatory factor analysis is that observed variables should have multivariate normal distribution. Bartlett's test is used to test whether the data have a multivariate normal distribution, while the KMO (Kaiser-Mayer-Olkin) value is employed to test the sufficiency of the data obtained from a sample (Tavşancıl, 2005). Besides, according to Harrington (2009), a non-normal distribution can be determined by skewness and kurtosis values for each variable. At this stage, Kline (1998) argues that for each item, skewness values should be lower than 3 and kurtosis values should be lower than 10 and values higher than these are problematic. Consequently, the first stage involved an examination of the correlation table, anti-image matrix, KMO-Bartlett values concerning the data, as well as the skewness and kurtosis values for each item. Analyses of the tables revealed high correlation for the 11th and 12th items, which were identified as items that assess similar characteristics given the items' characteristics. Therefore, the 12th item was removed from the scale. Moreover, the KMO value of the data was found to be .90 and the Bartlett's test was significant (χ^2=3666.167; df=703; p=.000<.05). Marshall et al. (2007) considers a KMO value above .50 as sufficient for factor analysis, while Barco et al. (2007) argues that perfect conformity is achieved for factor analysis with a KMO value equal to or above .90. Furthermore, an examination of the anti-image matrix showed that the values of sample sufficiency for all items were above .50 (Şencan, 2005; Marshall et al., 2007). What is more, the skewness and kurtosis values of each item were found to have a normal distribution by examining them on the basis of Kline's (1998) threshold values.

Factor analyses first made use of different rotational methods besides principal component analysis and correlation matrices. The most distinctive results concerning the factor items were obtained with the varimax technique

of orthogonal rotation and initial analyses were carried out by this technique. An examination of the rotated factor loadings revealed that the items in the scale loaded on nine factors with eigen values higher than 1. The items under each factor were examined and it was shown that there was no meaningful coherence among the factor items, except for those under the first factor. Therefore, developing a single-factor scale was decided. For the evaluating of the model, χ^2/df, RMSEA, RMR, SRMR, NFI, NNFI, CFI, GFI and AGFI values were taken into consideration.

In the process of factor analysis of the scale, the varimax technique of orthogonal rotation was employed to examine the obtained factors and all items with loadings above .40 in the first factor were taken into account. Items without a meaningful coherence in other factors were removed from the scale (17-16-11-14-13-20-19-5-22-38-36-42-10-8-7-3-4-2-15-9-1-18).

After removal of such items, factor analysis was repeated with 16 items in the first factor with loadings higher than .40 by taking the number of factors as one. The repeated factor analysis revealed a factor loading below .50 for the 35th item, which was thus removed from the single-factor structure. This single-factor structure subjected to exploratory factor analysis was determined to include items that can assess general attitude toward the constructivist approach. The data in the single-factor structure identified by exploratory factor analysis was subjected to confirmatory factor analysis to test compatibility with a single-factor structure. In confirmatory factor analysis, covariance matrixes was used and fit indexes was calculated. In the first analysis, χ^2 value is significance at .05 level, χ^2/df =2,94, RMSEA= .097, RMR= .054, SRMR= .028, GFI= .85, CFI =.91, NFI = .87, NNFI =.90 and AGFI = .80 are founded out. The analyses yielded low values of fit. Thus, the suggested modifications were examined for the model and a relationship was detected between the error variances of the 23rd and 24th items. Suggestions for modification are offered by software packages and serve as determiners

that guide the data in accordance with a new model that will most probably improve model fit (Harrington, 2009). Moreover, when a modification is suggested and there is a great decrease in χ^2, it usually means a real improvement in the model (Child, 1990). To Harrington (2009), suggestions for modification are in parallel with the simple χ^2 difference test. Therefore, a decrease in χ^2 in a suggestion for modification that is higher than 3.84 (p=.05; df=1) indicates a possible meaningful improvement in the model. However, it is not regarded as acceptable to add every modification into the model in confirmatory factor analysis. A modification to be added to the model should possess a certain theoretical background (Şimşek, 2007). In this context, this could be argued to be performed usually between meaningfully close items in the same factor when error covariance is added between the observed variables in a model. Since the 23rd and 24th items have a similar meaning, the model was tested again by adding error covariance between the items in the model. In the second CFA results showed that χ^2 value was significance at .05 level χ^2/df =2.32, RMSEA =.081, RMR = .049, SRMR =.025, GFI =.88, CFI =.94, NFI =.89, NNFI =.93 and AGFI = .84. As a result of interpretation of the obtained data, the new fit indices displayed a relatively better fit when compared to the previous analysis. It is also significant that the number of individuals in the study group was 205. Some studies have reported better results with certain CFA goodness-of-fit indices depending on sample size. Marsh et al.(1988) demonstrated in their study that the RMR, GFI, and AGFI values were positively affected by sample size. Similarly, Fan & Sivo (2007) also stated in their study that the NFI, GFI, and AGFI fit values had high sensitivity toward sample size. Widaman & Thompson (2003) argue that RMSEA value is relatively independent from sample size. As a result, the single-factor structure in question is clearly an acceptable structure. Figure 1 presents the path diagram concerning the standardized results obtained from CFA.

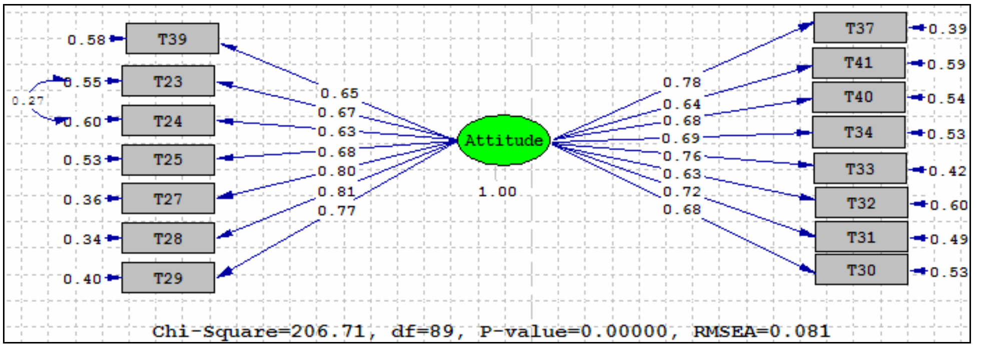

Fig. 1. Path diagram for the single-factor structure

Table 1 shows the items and item loadings, item-total score correlations, and upper and lower groups' discriminatory power in the single-factor structure following the exploratory and confirmatory factor analyses. For the items in the single-factor structure, the item total correlations vary between .759 and .567, while their factor loadings vary from .805 to .625. Moreover, for all items, the discriminatory results of the upper 27% group– lower 27% group t test were found to be significant at a significance level of .001. The variance explained by the single-group structure was calculated as 50.43% and its eigenvalue as 7.56.

Table 1. Factor loadings, item-total correlations, and upper-lower group discrimination for the items in the single-factor structure

No	Eigen value: 7.56 Cronbach alpha: .93 Explained Variance: % 50,43	Factor loads	Item-Total	Mean %27 upper	Mean %27 lower	t
29	I would do anything to learn about the constructivist approach.	.783	.736	4.45	3.07	12.00
27	Constructivism is an approach that deserves much emphasis.	.803	.759	4.58	3.29	10.29
28	The constructivist approach is suitable for my learning approach.	.805	.757	4.49	3.24	9.90
33	I like the constructivist approach.	.763	.711	4.51	3.44	9.58
37	I like using the constructivist approach in my classes.	.794	.748	4.55	3.65	8.32
34	I like reading books about the constructivist approach.	.696	.638	4.47	3.51	8.16

31	I would like to use the constructivist approach in teaching all my life.	.693	.639	4.44	3.20	8.98
32	I like informing others around me about the constructivist approach.	.625	.567	4.42	3.55	6.19
40	Constructivism is a useful approach.	.660	.607	4.47	3.49	7.77
25	I believe that I can benefit much from the constructivist approach.	.666	.612	4.67	3.35	9.30
41	I would like to conduct research on the constructivist approach.	.641	.584	4.45	3.18	8.30
30	I would not use the constructivist approach in teaching if I did not have to.	.699	.647	4.75	3.55	9.24
39	I am not interested in the constructivist approach.	.647	.595	4.75	3.58	10.31
23	I do not enjoy performing activities concerning the constructivist approach.	.668	.612	4.85	3.44	11.60
24	The constructivist approach is not interesting for me in any way.	.667	.615	4.85	3.62	10.42

p<.oo1 (in any cases)

The structure validation study was followed by the reliability process. In this process, the Cronbach alpha value was calculated to be .93. In their study, Spooren et al., (2007) suggested that a Cronbach alpha value above .70 is sufficient. The single-factor structure consists of a total of 15 items – 4 negative and 11 positive. Given its characteristics, it is clear that the scale can be used with its single-factor structure.

The development stage of the ASCAST involved the processes of exploratory and confirmatory factor analyses and the model with a single-factor structure produced in the exploratory factor analysis was tested by a confirmatory factor analysis. Table 2 shows the values of fit for the model with a single-factor structure produced as a result of exploratory factor analysis and the single-factor-corrected model.

Table 2 Comparison of the CFA indices of fit for different factor structures

Fit indexes / Models	χ2	df	χ2/ df	CFI	NFI	NNFI	GFI	AGFI	RMR	SRMR	RMSEA
One factor (1a)	264,31	90	2,94	.91	.87	.90	.85	.80	.054	.028	.097
One factor-Corrected (1b)	206,71	89	2,32	.94	.89	.93	.88	.84	.049	.025	.081

Studies often employ χ^2 difference test to compare the level of fit between models (Cramer, 2003; Kahn, 2006). According to Harrington (2009) and Kline (1998), the χ^2 difference test is a method that can be used to test the significance level of model improvement. This test is performed by subtracting from the χ^2 and df values of a given parent model the χ^2 and df values of an alternative child model and determining the significance level of this χ^2 value (Harvey et al., 2005). Table 2 presents the results obtained from a comparison of the single-factor model and the single-factor-corrected model. The results of the χ^2 difference test demonstrated that the single-factor-corrected model (1b) exhibited a significantly better fit than the single-factor model (1a) ($\Delta\chi^2$=57,60, Δdf=1, $p<.001$). In other words, error covariance added between the 23rd and 24th item in the single-factor model resulted in a significantly better fit for the model.

Discussion and conclusion

The study discussed the qualities that teachers should possess in learning environments that use the constructivist approach and the importance of teachers in learning process, and highlighted the need for determining teachers' attitudes toward the constructivist approach. Thus, the study dealt with an attempt to develop an attitude scale of constructivist approach for science and technology teachers. A general literature review revealed similar studies, though not exactly the same. Kesercioğlu et al. (2009) conducted a study on developing a scale on teachers' opinions about the constructivist approach. In a similar study, the same authors developed a scale on prospective teachers' opinions (Balım et al., 2009). In a study, Karadağ (2007) developed the "Scale on Teacher Competency about the Constructivist Approach". Fer & Cırık (2006) investigated in their study the language equivalency, validity, and reliability of the Turkish version of the "Constructivist Learning Environment"

scale. Considering these studies, no other study was detected with the same characteristics as attitude scale of constructivist approach for science and technology teachers developed in the present study. Thus, the study is believed to have an original value.

The pre-applications for the development of the attitude scale were carried out with science and technology teachers employed in different provinces, each province being in a different region in Turkey. The analyses on the data obtained from the pre-applications showed that the scale can be developed with a single-factor structure and thus, the single-factor structure in question was tested by confirmatory factor analysis. The results of the confirmatory factor analysis demonstrated that the single-factor-corrected model for the scale had a better fit with the data when compared to the single-factor model. In the light of the results of the study, it is believed that: (1) The scale could be used by researchers in experimental and descriptive studies with different factor structures; (2) Further studies that will employ the scale might deal with testing its factor structure and its compatibility to the obtained structure, as well as its use in different samples; (3) Different studies on scale development should be conducted to identify teachers' affective qualities in and out of classroom environment by considering teachers' role in the constructivist approach.

REFERENCES

Bağcı-Kılıç, G. (2001). Oluşturmacı fen öğretimi [Constructivist science teaching]. *Educational Sciences: Theory & Practice*, *1*(1), 7-22.

Balım, A.G., Kesercioğlu, T., Evrekli, E. & İnel, D. (2009). Fen öğretmen adaylarına yönelik yapılandırmacı yaklaşım görüş ölçeği: bir geçerlilik ve güvenirlik çalışması [Constructivist approach opinion scale for pre-

service science teachers: a study of validity and reliability]. *Inonu University Journal of The Faculty of Education*, *10*(1), 73-85.

Barco, B.L.D., Castaño, E.F., Carroza, T.G., Delgado, M.. & Pérez, C.L. (2007). Scale of attitudes of school children towards immigrant pupils. *European J. Psychology of Education, 22*, 439-454.

Berberoğlu, G. (1990). Kimyaya ilişkin tutumların ölçülmesi [Measuring of the attitudes toward chemistry]. *Education and Science*, *76*, 16-27.

Child, D. (1990). *The essentials of factor analysis*. London: Cassel Educational Ltd.

Cramer, D. (2003). *Advanced quantitative data analysis*. Berkshire: McGraw-Hill Education.

Çetin, Ş. (2006). Öğretmenlik mesleği tutum ölçeğinin geliştirilmesi (geçerlik ve güvenirlik çalışması) [Establishment of the profession of teaching attıtude scale (the study for validity and confidence)]. *The Journal of the Industrial Arts Education Faculty of Gazi University, 18*, 28-37.

Ekici, G. (2002). Biyoloji öğretmenlerinin laboratuvar dersine yönelik tutum ölçeği (BÖLDYTÖ) [The attitude scale of biology teachers toward laboratory lesson (ASBTTLL)]. *Hacettepe University Journal of Education*, *22*, 62-66.

Fan, X. & Sivo, S.A. (2007). Sensitivity of fit indices to model misspecification and model Types. *Multivariate Behavioral Research.*, *42*, 509-529.

Fer, S. & Cırık, İ. (2006). Öğretmenlerde ve öğrencilerde, yapılandırmacı öğrenme ortamı ölçeğinin geçerlilik ve güvenirlik çalışması nedir?. *Edu7, 2*(1), 1-26.

Harrington, D. (2009). *Confirmatory factor analysis*. New York: Oxford University Press.

Harvey, P., Sinclair, C. & Dowson, M. (2005). Teacher motivations for postgraduate study: development of a psychometric scale for christian higher education. *Christian Higher Education*, *4*, 241-264.

Kahn, J.H. (2006). Factor analysis in counseling psychology research, training, and practice: principles, advances, and applications. *Counseling Psychologist*, *34*, 684-718.

Kan, A. & Akbaş, A. (2005). Lise öğrencilerinin kimya dersine yönelik tutum ölçeği geliştirme çalışması [A study of developing an attitude scale towards chemistry]. *Mersin University Journal of the Faculty of Education*, *1*(2), 227-237.

Karadağ, E. (2007). Development of the teachers' sufficiency scale in relation to constructivist learning: reliability and validity analysis. *Education of Sciences: Theory and Practice. 7,* 167-175.

Kelloway, E. K. (1998). *Using LISREL for structural equation modeling: a researcher's guide.* New York: Sage Publications.

Kesercioğlu, T., İnel, D., Balım, A.G. & Evrekli, E. (2009). An opinion scale of constructivist approach for science teachers: a study of validity and reliability. *Procedia - Social and Behavioral Sciences*, *1*, 2274-2279.

Kline, R.B. (1998). *Principles and practice of structural equation modeling*. New York: Guilford Press.

Köseoğlu, F. & Kavak, N. (2001). Fen öğretiminde yapılandırmacı yaklaşım [Constructivist approach in science teaching]. *Journal of Gazi Education Faculty*, *21*(1), 139-148.

MacCallum, R.C., Widaman, K.F., Zhang, S. & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, *4*, 84-99.

Marsh, H.W., Balla, J.R. & McDonald, R.P. (1988). Goodness-of-fit indexes in confirmatory factor analysis: the effect of sample size. *Psychological Bulletin*, *103*, 391-410.

Marshall, A.P., Fisher, M.J., Brammer, J., Eustace, P., Grech, C., Jones, B. & Kelly, M. (2007). Assessing psychometric properties of scales: a case study. *Journal of Advanced Nursing*, *59*, 398-406.

Nuhoğlu, H. & Yalçın, N. (2004). Fizik laboratuvarına yönelik bir tutum ölçeğinin geliştirilmesi ve öğretmen adaylarının fizik laboratuvarına yönelik tutumlarının değerlendirilmesi [The development of attitude scale for physics laboratory and the assessment of preservice teachers' attitudes towards physics laboratory]. *Gazi University Journal of Kırşehir Education Faculty (JKEF)*, *5*, 317-327.

Rosenfeld, M. & Rosenfeld, S. (2006). Understanding teacher responses to constructivist learning environments: challanges and resolutions. *Science Education*, *90*, 385-399.

Selley, N. (1999). *The art of constructivist teaching in the primary school*. London: David Fulton Publishers.

Spooren, P., Mortelmans, D. & Denekans, J. (2007). Student evaluation of teaching quality in higher education: development of an instrument based on 10 Likert-scales. *Assessment & Evaluation Higher Education*, *32*, 667-679.

Şencan, H. (2005). *Sosyal ve davranışsal ölçümlerde güvenilirlik ve geçerlilik [Reliability and validity in the social and behavioral measurement]*. Ankara: Seçkin Publishing.

Şimşek, Ö.F. (2007). *Yapısal eşitlik modellemesine giriş: temel ilkeler ve lisrel uygulamaları [Introduction to structural equation modelling: Basic Principles and Lisrel application]*. Ankara: Ekinoks Publishing.

Tavşancıl, E. (2005). *Tutumların ölçülmesi ve spss ile veri analizi [Measuring attitudes and data analysis with spss]*. Ankara: Nobel Publishing.

Tezbaşaran, A. (1997). *Likert tipi ölçek geliştirme kılavuzu [The guide of the likert type scale development]*. Ankara: Turkish Psychological Association Publishing.

Watson, J. (2001). Social constructivism in the classroom. *Support for Learning*, *16*, 140-147.

Watts, M., Jofili, Z. & Bezerra, R. (1997). A case for critical constructivism and critical thinking in science education. *Research in Science Education*, *27*, 309-322.

Widaman, K.F. & Thompson, J.S. (2003). On specifying the null model for incremental fit indices in Structural equation modeling. *Psychological Methods*, *8*, 16-37.

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THE USE OF SIMULATION BUSINESS GAMES IN UNIVERSITY EDUCATION[1)]

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Abstract. Rapid and deep changes in economics and business environment along with the dynamic development of computer art and communication technologies represent the main factors identifying the development in the area of simulation business games. These games may be considered a strange, content-determined group of simulation games. The description of their content specialties, basic elements, and possibilities of their use are the essence of our report. In the conclusion we present a short research carried out at the Faculty of Management of the University of Prešov in Prešov where we made an investigation of the students´ opinions on the use of business games in the university educational process.

Keywords: simulation business games, process of education, future managers

One of the methods of university education on the basis of experience is the use of simulation games. A simulation game is most frequently defined as a technique securing an artificially created environment that copies chosen

features of real situations, which enables the participants observe the results of their decisions and react to them (Angelides & Paul, 1999). It is then possible to regard business games as a strange, content-determined group of simulation games. These games simulate a hypothetical business, economic, or managerial environment and thus enable an active social communication of the real players in quasi real business conditions.

When defining the term „simulation business game“ it is necessary to begin from the general level because the group of business games is actually a subset of a broader, more general group of simulation games, which are not only business-based. The term „simulation game“ is a compound phrase containing the terms „game“ and „simulation“. The term game is usually defined as a structured activity, in which two or more participants compete according to certain rules to reach a certain goal. Kirk (1997) similarly defines game as a set of activities which require performing tasks, playing assigned roles, and following conventional rules, which then leads to the achievement of the preset goals. Simulation (from Latin simulō) means to imitate. Simulation game can be thus defined as a set of structured and dynamic interacting particles which mutually affect one another for the purpose of reaching a certain goal. These relations have partly a pre-arranged character and partly they are randomly created by the participants of the game (Siegel, 1977). Simulation game therefore includes both aspects, the aspect of simulation represented more or less by a formal dynamic model of a chosen part of reality, and the aspect of a game represented by an active participation of real players. Simulation in a simulation game is then periodically interrupted for the purpose of evaluation of their results which are an outcome of the previous behavior and decisions of the players.

The most influential approach in the area of business education is Kolb´s experiential learning theory. According to Kolb, learning is most effective when it is directed and controlled by the learner and based on the

learner´s own practical experience, thus it has a concrete sense and meaning for this person (Pavlica et al., 1998). In accordance with their model, individuals learn effectively when they intentionally transform their concrete experience, reality and problems they encountered and are related to them by means of reflective (thoughtful) observation. They analyze the behavior which lead to an experience, human relations and surrounding factors which affected this experience, and for future use they create an abstract image – their own perception of reality. The whole process of learning continues with a phase of active experimentation which leads to the new experience that is to be analyzed, named, and understood.

1. Concrete Experience
(ense-perception and feelings)
„Activists“

4. Active Experimentation
(aplication, activity)
„Pragmatists“

2. Reflective Observation
(hindsight at the experience, observation)
„Reflectors“

3. Abstract Conceptualization
(thinking and categorization)
„Theorists“

Fig. 1. Kolb’s experiental learning theory (after Petty, 1996)

Effective learning assumes remembering the cyclic process of experiential learning. It is appropriate to always go through all phases of learning: experience and activities (a case study with a description of a situation where people from different cultures live together) followed by reflection (what happened, how individuals felt, who was/was not involved, what tasks were in the group activity, what was accomplished and how they proceeded, which questions were left unanswered, etc.). Reflection is followed by the development of conclusions from the experience, that is, theoretical conclusions about the theme or the process (procedure, ways of decision-making, etc.) created by the students. In this learning phase, students expand their knowledge by adding new information. Experimentation, questions, or tasks for the application of a concrete situation can warn the learners that even theoretical conclusions are „useful“ because thanks to them we can solve a problem and look for possibilities of their use. Having an opportunity to experiment is an essential „anchor“ of knowledge in learning.

According to the approach to learning, students are divided into four types: those, who gain information primarily from a direct empirical experience are so-called *„Activists“* (they do not have a problem to participate in activities). Activists participate in new situations fully and without prejudice, they are open, understanding, and prone to excitement. They jump into new activities without thinking, their days are full of activities. They solve problems on impulse and react dynamically to new experience. They are sociable and look for contacts with other people. Sometimes they are inconsiderate when they try to assert themselves as the centres of attention.

Then in accordance with the „cycle of learning“ there are students who rather observe and from their observations they form their opinions about the world (so-called *„Reflectors“*). Reflectors keep distance, they observe things from different perspectives and different angles. They use various ways to collect data and they think them through before they arrive to the conclusions.

Once the collection of the information is completed, they analyze it thoroughly and reconsider the possible consequences. They are precise and thorough, and usually not very active. They create a calm, although quite impersonal aura around themselves.

Among students there are also „*Theorists*“ who create mental constructs for themselves. They use analytical thinking, they are capable of categorizing and comparing, and they like lectures and projects. Theorists examine problems step by step by a vertical and logically correct way. They tend to be perfect and avoid resting until they are certain that all things are arranged. They like analysis as well as synthesis, basic principles, theories, and models. Logic is good. They are not prone to being emotional, they are analytical and respect only rational objectivity. They treat problems mainly by using logic.

What is characteristic for „*Pragmatists*“ (experimentators) as learners is that they like taking risks, they verify and evaluate things on the basis of experimentation or practical realization, and their starting point when learning is the real world. Pragmatists like trying new ideas, theories, and techniques in confrontation with the practice. They approach new ideas positively and realize them practically. Their desire is to try all new ideas and inspirations in practice immediately. They act swiftly and skillfully when doing things they like. They are practical and realistic, having both feet on the ground. They like making practical decisions and solving problems. Problems are a challenge for them.

The essence of simulation business games is creating a quasi real environment within which the participants gain important experience for the following reflection. Simulation business games thus enable the development of all components of human capital (not just, for example, knowledge). The development of human capital is therefore more complex and it takes place on all levels. At the same time it is more effective because it stems from the

participants´ own practical experience. They can contribute to the identification of possible problems in this area and to finding an optimal solution so that the key knowledge, abilities, and skills (whether existing or acquired) could be more effectively used when fulfilling the goals of the company.

Forssén-Nyberg & Hakamäki (1998) emphasize these basic features of simulation games: (1) every simulation game must be a reflection of reality; (2) a simulation game must involve an active social communication of live participants; (3) one of the goals is the evaluation of reality, self-evaluation, and reflection.

The first simulation games feature clearly results from Kolb´s requirements. If an experience in the game should be the basis for further process of learning, it must be realistic, or quasi realistic, thus gained from a real environment or a reality very similar in relevant aspects. Such environment is created by the game rules. An advantage of simulated environment is its safety, which has usually a positive influence on the whole process of learning.

Basic components of a simulation game

It is possible to say that an own simulation game is a system consisting of certain elements and mutual bonds between these elements. Angelides & Paul (1999) identified the basic elements that create the environment of a simulation game. Game goals (the goals of the players in a game) define the victory in a game. They may be considered as a basic impulse which directs the player and keeps the game going (along with other impulses). The desire to win is an important motivation factor for the participants of the game.

The basis of every simulation game is its script, which defines its basic subject matter, content orientation, and initial conditions, and which concentrates on every important aspect of successful participation in a

simulation game. On the basis of the script, the individual roles are defined. The roles are persons or functions assigned to individual students, players (teams). They determine motivations, formulas for behavior, and relations to the other roles within a simulation game. The roles have their models in a simulated reality. There are three types of roles: (a) played roles – based on the game script, built in the course of the game, represented by live players who perform their actions and make decisions within their course; (b) simulated games – built in the course of the game, but not assigned to live players; their actions and decisions are simulated on the basis of simulation models or game rules; (c) pseudo-roles – not based on the game script; the roles with the purpose to fulfill the immediately needed function (for example, judges or technical experts).

The definitions of individual roles must progress in a close tie-up to create the rules of the game. These rules regulate the behavior of players, who act according to individual roles and situations that may come up during a game. However, they may also contain the conditional reactions from the environment, meaning they may express the actions of people which are not part of the game (simulated roles) but their reaction is relevant for the behavior of real players – played roles (Coleman, 1975). If the rules contain these conditional reactions, it is necessary to create them on the basis of the gained theoretical or empirical information. If the reactions from the environment are part of the rules, the creators of the game must have a clear idea about the set of possible reactions of the system to the stimuli that come from the live players (played roles). Simulation games use both types of these rules because one part of the environment presented within a simulation game is always simulated, and one is always represented by means of played roles.

Coleman (1975) defines 5 kinds of rules: (I) procedure rules – describe how to play a game, and define the way the game progresses. They are based on empirical observations of the presented reality and they implicitly involve

theoretical assumptions about functioning of the processes presented by the game; (II) rules that restrict behavior – oblige what players (individual roles) must or may not do. They help to define individual roles. They must be in line with the responsibilities of the individual roles in real life, imitated by the game; (III) rules defining goals – exactly define the goals of individual roles within a game. It is particularly important to make sure that the role is correctly defined in accordance with its goals and motivations; (IV) rules defining reaction of environment – specify the reaction of the simulated part of the game environment. They are directly tied to the simulated roles. These rules regulate reactions of that part of the environment which is not presented in a game by real actions of live players (played roles); (V) controlling rules – define the outcome of breaking of the rules by players (played roles). The goal of exercising the controlling rules is to ensure following the game rules and to clearly define the way of correction of their breaking.

Games are divided into a certain number of stages. Each cycle is further divided into several steps. The individual steps are collections of activities which progress in a certain sequence within one cycle, and thus push the game forward. The most typical is the cycle of four steps: 1) initiation – result of a concrete impulse. The players become familiar with the script or new data and information which are a result of the preceding cycle; 2) planning – takes place on the basis of analyzing the available information; 3) action – based on the decisions adopted according to the results from the preceding step, certain activities which should lead to the given goals take place; 4) evaluation – the last step of the cycle. Simulation is paused in order for the discussions over the results from the given cycle to take place.

After evaluation, a new cycle begins, and its first step is again initiation. The function of initiation is fulfilled by so-called impulses. They are events or problem situations which force players (students) to concentrate on a certain aspect of the simulated problem. Impulses may be initiated by the

teacher (lecturer of the game) or they might be initiated by the students (players) themselves by means of their actions. They may be prepared or spontaneous.

Angelides & Paul (1999) then divide games into system games and role-plays. System games focus on the mutual relations and relations among the elements of the economic, political, or social system, and players develop their own formulas for behavior within the defined roles. In the system of role-playing, players focus on the concrete real-world positions and relations among these positions. Ferencová (2008) defines role-playing as an active teaching method based on a script according to which the participant in a group should play certain roles. It is a very effective tool which requires a carefull approach. Other non-traditional, innovative forms and methods of experiential learning in higher education are also described in works of Zahatňanská (2009), Ferencová & Birknerová (2009), and others.

It can be stated that there are many possibilities for an effective use of simulation business games for educational purposes. We include such business games in the process of education at the Faculty of Management of Prešov University in Prešov as part of the subject called Organizational Behavior.

Research

The research realized at the end of the term involved simulation business games which we included in the process of education within the subject called Organizational Behavior. The main objective of the research was to find out the opinions of Management students on this form of teaching. The questionnaire was given to 213 students of the fourth year at the Faculty of Management of the University of Prešov.

Question 1: What is your opinion on the teaching of Organizational Behavior by means of simulation business games?

Majority agreed that this form of teaching is a great contribution because it leads them to creativity. During seminars, they gained a positive image of themselves, self-assurance, and they learned how to resist constraining, to take more risks, to be more independent, and to be more self-confident. Besides motivation to creativity, they learned how to evaluate and assert themselves. When describing their answers, we can talk about the mentioned motivation to creativity, creativity in human relations, and creativity in values which support creativity.

Students learned how to motivate, develop their knowledge in meaningful units, support the development of independence, self-evaluation and responsibility, to develop self-assurance and self-confidence, the willingness to take risks when solving problems, and to develop individual abilities. They learned hot to initiate the production of thoughts, ideas, questions, as well as how to create a creative atmosphere in a group, where also humor is applied.

Question 2: Were the seminars carried out by means of simulation business games a contribution for you as future managers? In what?

Majority of the respondents agreed that during one term they gained a great number of new experience and knowledge, and they adopted new principles which can be used in real life. We summed up the most frequent answers to the question what they liked about the games: (i) Active participation of each member of the group; (ii) Respect for the other members of the group; (iii) Open manifestation of own feelings and opinions in front of other students; (iv) Providing a feedback, backward information about how one member of the group is affected by the behavior of other members; (v) Experimentation with own behavior on the basis of use of the feedback information. Self-understanding by means of self-reflection as well as other people (so-called social feedback); (vi) Everyone has a right to stop the action

in a group and ask for explanation if something is unclear; (vii) Everyone has a right to be given audience. Other students listen to every person talking; (viii) If someone wants to participate in any activity, it is their right to do so; (ix) Students learned how to speak briefly and to the point, not avoiding the actual topic; (x) Members of a group speak for themselves. When forming their thoughts, they differentiate between their own opinions and thoughts, and opinions and thoughts of others; (xi) They also learned how to speak directly. If they want to announce something to someone, they name the person and speak to that particular one. They do not speak in the third person; (xii) Members of a group differentiate the activity from the person, they do not react to the person but to their demonstration. Information and reactions are related to the activities, action, and opinions, not to the person as such; (xiii) There is a rule of discretion and information confidentiality in a group. Everything mentioned within one group is their shared property.

Question 3: Which methods that were used in seminars do you consider most interesting?

Majority of the respondents stated that the most interesting for them was the practice in communication competence. They gained experience from the exercise of non-verbal communication, for example face-play, posture, and look, as well as verbal monological and social communication. A well-spoken dialogue presumed respect for the following requirements: interconnection of ideas, no enforcing of topics, approximately the same time entry of participants, no interruption when speaking, no humiliation, no ironization, no sermonizing, toleration for other opinions, no blaming, no enforcing of spontaneous emotions, etc. Students appreciated the exercise in dialogue communication and they also made a motivating evaluation of group discussions, which can be related to any topic and which build closer relations. They learned not only to express themselves in a clear and well-

spoken manner, but also to listen, understand, and accept opinions of others.

The respondents also stated how contributive is gaining assertive skills by menas of the method of assertive „obligations“ through which they gained control over their behavior because they learned how to give a brief and honest explanation for the causes of their behavior. They learned to respect personal rights, avoid confrontation, work on a compromise which would suit both parties, and also control own emotions.

Conclusion

At last we can conclude that business simulation games may be used as a tool for development of human and total intelectual capital of a corporation. If respecting the mentioned principles, they can be an effective tool for increasing the human capital of the corporation management. The goal of the games is to create a competition atmosphere for cooperation of students and their abilities to organize team work, to form visions of fictitious corporations, to concentrate the effort of co-workers on sharing mutual values, to gain and process information, make decisions, give tasks and motivate, to deal and negotiate. Students actively participated in the process of education, they learned new knowledge, skills, and abilities, reaffirmed their previously acquired knowledge, changed their values and attitudes, and they were able to include the newly gained knowledge in the context of real life. Seminars enabled them to understand human behavior better.

In order for simulation games to be successful, during one term, members of the groups had to create harmonious relations by means of getting to know and supporting each other. There were constant group processes among them. Each student could, on the basis of experiential learning, verify how difficult is to influence or even change their own behavior in a group. Attendance at the simulation business games enabled students to adopt new, better group behavior. The games are an example of complex education of a

quite strange kind which involves new knowledge, understanding, new attitudes and skills. The non-traditional way of teaching enabled each member of a group to experiment with their own behavior. Each student could then verify how the new elements influenced their behavior. Active participation in the games during a seminar enabled students to uncover the relation between their internal problems and difficulties they experience during interaction with people. Members gained a deeper view into their social performance and thus they realized how their behavior affects other people. The primary goal of simulation games was to achieve that the participants change their behavior in such way that would make them more successful in social situations. We believe we reached this goal.

NOTES

1. A version of that paper has already been published (2010) in *Manažment v teorii a praxi*, *6*(1), 4-14.

REFERENCES

Angelides, M.C. & Paul, R.J. (1999). A methodology for specific, total enterprise, role-playing, intelligent gaming-simulation environment developmnent. *Decision Support Systems*, *25*, 89-108.

Coleman, J.S. (1975). Social processes and social simulation games (pp. 180-247). In.: Greenblat, C.S. & Duke, R.D. (Eds.). *Gaming simulation: rationale, design and applications.* New York: Sage.

Ferencová, M. (2008). Hra a hranie rolí v procese vzdelávania budúcich manažérov (pp.278-284). In.: Lačný, M. & Dudinský, V. (Eds.). *Medzi modernou a postmodernou IV. Súťaživosť ako kultúrotvorný fenomén – limity efektivity.* Prešov: Prešovská univerzita v Prešove.

Ferencová, M. & Birknerová, Z. (2010). *Experiential learning of university students.* In.: Conference Application of Management Theory in Practice IV. *Leadership styles and future managers.* Bratislava:

Ekonóm.

Forssén-Nyberg, M. & Hakamäki, J. (1998). Development of the production using participative simulation games: two case studies. *Intern. J. Production, 56-57,* 169-178.

Kirk, J.J. (1997). Thrainer's use of games: some preliminary explorations. *Simulation & Gaming, 28,* 88-97.

Pavlica, K., Holman, D. & Thorpe, R. (1998). Manažer v roli „praktického autora a mediátora učeni". *Psychologie v ekonomické praxi, 33,* 89-96.

Petty, G. (1996). *Moderni vyučováni.* Praha: Portál.

Siegel, G.B. (1977). Gaming simulation in the teaching of publuc personnel adminstration. *Public Personnel Admistration, 6,* 236-249.

Zahatňanská, M. (2009). Zážitkové učenie a jeho možnosti v pregraduálnej príprave (pp. 164-168). In.: Editorial staff: International Scientific Conference *Rozvoj a perspektívy pedagogiky a vzdelávania učiteľov*. Prešov: FHPV PU.

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EVALUATION OF THE USABILITY OF DIFFERENT VIRTUAL LAB SOFTWARE USED IN PHYSICS COURSES

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Abstract. In recent years the use of virtual lab software has become ubiquitous in education settings. The purpose of the current study is to develop an Evaluation Scale to allow the easy and fast assessment of virtual lab software. During the development of the Evaluation Scale, theoretical and experimental studies investigating the effects of different software on learning, particularly in terms of usability, were utilized. The Evaluation Scale was created by adding new attributes to pre-existing scales, and comprises three sections – attributes related to the interface of the software; attributes related to its use as a material in education; and attributes related to product and service support – and 79 items. Testing of the Evaluation Scale was carried out using two different virtual lab programmes, with the help of a checklist. The evaluation was carried out by physics teachers and academics that had previously used similar software, and consistency between the results was considered to represent inter-rater reliability. At the end of the study, the usability of the Evaluation Scale was tested, and the instructor evaluations regarding the

usability characteristics considered sufficient and that require improvement in virtual lab software were also investigated.

Keywords: virtual labs, usability, evaluation scale, physics education

Introduction

The need for technology increases with the development of special teaching methods in education. The variety of materials used in education increases in parallel with the rapid change in technology. This diversity provides teachers with assistance in teaching, while presenting distinctive environments and applications for students relating to their field of study. Recently, virtual labs have become ubiquitous in science and engineering education. Virtual labs enable students to repeatedly carry out experiments in a safe environment during lessons. Jeschke et al. (2001) and Budhu & Coleman (2002) assert that the short-term purpose of virtual lab programmes is to support actual physics laboratories, while their long-term purpose is to replace them. Virtual labs create a convenient learning environment that takes into consideration the individual's characteristics (Guzzi et al., 2005; Noor & Wasfy, 2001). These programmes also provide an affordable, safe, easy and ideal working environment.

In addition to the information regarding in which field and for what purpose the virtual labs will be used, their attributes should also be specialized to their respective field. For example, the virtual lab to be used in physics courses should have different attributes to that one used in biology courses. This situation makes field-specific studies more necessary. Evaluation Scales prepared specifically for different fields would be beneficial for teachers and students alike. In order for virtual labs to make the expected contribution to students' achievement, they should be well-designed and have the required usability characteristics. Such software, which is preferred for individual edu-

cation and used for students' self-study, should be correctly designed and have functional software features. The literature review conducted showed that different perspectives were adopted regarding the usability attributes that a virtual lab programme should have, and that different attributes were used in each study. Some of these studies listed simulation software attributes (Budhu & Coleman, 2002; Nikoukaran et al.,1998; Subramanian & Marsic, 2001), while others investigated the use of simulation software in education (Gabbard, Hix & Swan, 1999; Jensen *et al*., 2004; Serra et al., 1999; Weissmann & Yahel, 1999).

All these distinctive perspectives create a problem for school administration, teachers and students, who are faced with the following question: Which attributes should be taken into consideration in the selection of virtual lab software? Bringing together and developing the attributes formed from different perspectives would provide benefits to teachers and students using virtual labs. Indeed, many studies indicate that teachers' attitudes towards computers become more positive as their knowledge and experiences regarding computers increase (Galanouli et al., 2004; Levine & Donitsa-Schmidt, 1998; Potosky & Bobko, 2001; Rozell & Gardner, 1999; Williams et al., 2000). Increasing the awareness of teachers regarding the selection and evaluation of software will also have positive impacts upon their attitude towards such software.

The purpose of this study is to develop an Evaluation Scale that can be used to evaluate the usability of the virtual lab software used in physics lessons. Furthermore, the usability of two different virtual lab programmes was evaluated with the help of the Evaluation Scale developed. The test stage of the Evaluation Scale was carried out, then the evaluation results of the teachers were examined.

Literature

Virtual physics labs are highly interactive software, comprising simulations of real physics labs customized for the needs of researchers and students (Noor & Wasfy, 2001). These software programmes provide students with the opportunity to study under the control and within the knowledge of the teacher, and to learn using trial and error (Guzzi et al., 2005). The most important attribute of virtual physics labs is that they should have a highly interactive user interface. Users are able to perform experiments using the laboratory materials in any order by moving the objects using input devices (Scherp, 2002).

According to Özdener (2004), virtual labs are tools that simulate phenomena that cannot be investigated or observed in natural environments or in cases where the lab facilities are limited. Thanks to these programmes, users have the opportunity to learn by experimenting and testing using different parameters. For example, they provide the opportunity to perform experiments in different environments with different gravitational forces (e.g., on another planet or at the poles), and to investigate the incidents in detail by controlling the time (e.g., slowing down the movements of electrons in a conductor for easy observation). Furthermore, virtual labs also provide the opportunity to conduct investigations and experiments without harming any living creatures. Virtual labs are capable of simplifying experiments based on the user's skill level. For example, they enable users to understand the subject and solve the problem by showing multiple forces affecting an object directionally.

Usability and attributes

Usability is a quality attribute that assesses how user-friendly the user interface is. It is identified by Nielsen[1)] and Gündoğan (2003) as having five important quality components: (1) *Learnability:* how easy it is for users to accomplish basic tasks the first time they encounter the design. Keeping com-

pliance to the standards that the user is accustomed is the functional usage of the program. Amongst such factors influencing the same are included the design of the interface, language used, as well as its similarities in application of certain tasks (like opening-closing of the program) to other programs; (2) *Efficiency*: once users have learned the design, how quickly they can perform tasks. After the users receive usability training with respect to the program, they are capable of reaching the level to meet their requirements and carry out the procedures in very short notice; (3) *Memorability*: when users return to the design after a period of not using it, how easily they can re-establish proficiency. Is the nature of the program being easily remembered by the users, and therefore, the program is required to comply with the standards and have a simple interface; (4) *Errors*: how many errors users make, how severe these errors are, and how easily they can recover from these errors. Is its usability in such nature as avoiding the users making mistakes, in an active manner under accurate directives? It should enable facilities for the user to compensate any errors made; (5) *Satisfaction:* how pleasant it is to use the design. The usage of the program should be easy, with an esthetic, functional interface design, capable of meeting requirements of the users. The users should be able to carry out any applications they so desire, in an active manner without contradicting in their applications.

Another key quality attribute that affects usability is utility. A positive reply to the question “Does it do what users need?” will be an important factor in improving the usability of the programme. Continuous use of the programme, the motivation for learning, being clear, and being beneficial are also important (Ezginci et al., 2006).

According to Malloy & Jensen (2001), the usability attributes of virtual labs should be as follows: (1) *Password Access:* To enable the programme to make individual evaluations, users should be allowed to log-in to the system using an individual password. The performance of each and every

user should be measured and assessed by entering into the system under its own user name as well as password; (2) *Examples:* The programme should provide users with examples in order to improve usability. There should exist in the program sample experiments demonstrating how any experiment structure is created. Such samples should be rather in the form of demonstrations and self-explanatory; (3) *Selecting the Independent Variable:* The programme should provide users with the facility to select any object and to create any experiment mechanism. While creating the experimental structure, the user should be independent. It should be able to create different experimental structures and observe the results of the same in a manner similar to those in real life; (4) *Representing the Experimental Design:* The programme should be capable of reporting the experiments performed by users. Any experimental structures created should include presentations that are both mathematically accurate, and also with the events depicted being similar to those in real life. They should enable the user to report the results pertaining to each and every experimental structure and compare the same under different parameters; (5) *Setting the Dependent Variable:* The programme should contain environments that encourage users to research. It should enable the comparison of the results under different features of the experimental structure so created; (6) *Authoring:* Users should be enabled to find different examples relating to the subject, to create the mechanisms explained, and to see and interpret the results. The user is free to create experimental structures, and it should be able to observe the results of any experiment created in a manner similar to those events in real life; (7) *Data Analysis:* On the basis of their knowledge of the research design they create, users must choose appropriate data analyses. While creating the experimental structure, each and every object selected should be equipped with data (such as upper and lower limit values) in compliance with its features in real life; (8) *Conclusion and Research Report:* Users should be able to see the results of the experiment they created and the

experiment mechanisms they operated. Results of the experiment should possibly be presented graphically as well as in the form of reports, so as to act as exact equivalents of those in real life. At the end of the experiment, the program should be make mathematical calculations in an accurate manner and display a result similar to that in real life.

Virtual labs[2)] should have strong presentation that satisfies users. The content should be plain and clear, and not cause misunderstanding, and the subject should not divert the user from the relevant targets. Students should be able to select the experiment tools by looking at their shapes, placing them in the working environment using the mouse, and changing the links freely (Serra et al., 1999).

According to Sanchez et al. (2004), students should be able to test the modules they create and change the attributes of the experiment tools. Furthermore, the links and experiment tools that have been selected for changing should turn a different color. Before adding a tool to the experiment mechanism, users should be able to test whether they are faulty, and to derive preliminary information about the operating order of the programme (Nikoukaran et al., 1998; Serra et al., 1999). Studies show that virtual lab programmes should be capable of running on a web browser using a form of presentation that tests and interprets the experiment mechanism created by students (Ezginci et al., 2006; Gustavsson, 2002; Keyhani et al., 2002; Lin et al., 2002; Shen, 1999; Yeung & Huang, 2003).

Bateman et al. (1997) and Harrell &Tumay (1995) investigated the human-computer interaction by developing a variety of scales in a number of studies. The attributes prescribed in the scales show that educational software should be easy-to-use, motivating, and support learning in a number of ways.

Method

The research model is both descriptive, aiming to determine the attributes of the virtual lab software developed for use in secondary education physics courses as a result of the literature review, and methodological, aiming to develop an Evaluation Scale. Firstly, some of the virtual laboratories available were examined and an Evaluation Scale comprising 110 items was developed in line with the literature review. Subsequently, the scale items that were difficult to understand, determined to be immeasurable, or that partly match up with each other were identified, and necessary corrections were made as a result of the pilot work carried out. Based on the final arrangements, a dual Likert-type Evaluation Scale comprising 79 items was developed.

Methodological study group

The Evaluation Scale was evaluated by forty nine physics teachers and five academics that had previously used virtual lab programmes.

Data collection tools

At the development stage of the Evaluation Scale, theoretical studies that demonstrate the attributes required for educational software and offer recommendations were reviewed and the usability attributes required for educational software were identified. Furthermore, studies conducted in the field of learning psychology investigating the usability of different software during the process of learning were reviewed; thus, the theoretically identified attributes were supported by the results of empirical research, and new attributes were added.

Companies that develop simulation software and books dealing with human-computer interaction were also examined, with the data obtained forming the scale attributes. It was ensured that these attributes were of a

quality that could be easily understood and not open to different interpretations. For example, the Evaluation Scale items were prepared in such a way that the respondent can only choose “Yes” or “No” answers. The respective study groups used two virtual lab programmes, so the symbol “C” indicates Crocodile Physics 401, and the symbol “E” indicates Edison4.

The virtual lab programmes used in this study

The following virtual lab programmes were obtained by contacting the companies that develop them.

Crocodile Physics 401: This programme was developed by the Crocodile Company, and provides a laboratory environment for some secondary education physics subjects (dynamics, kinetics, forces, waves, optics, and electricity).

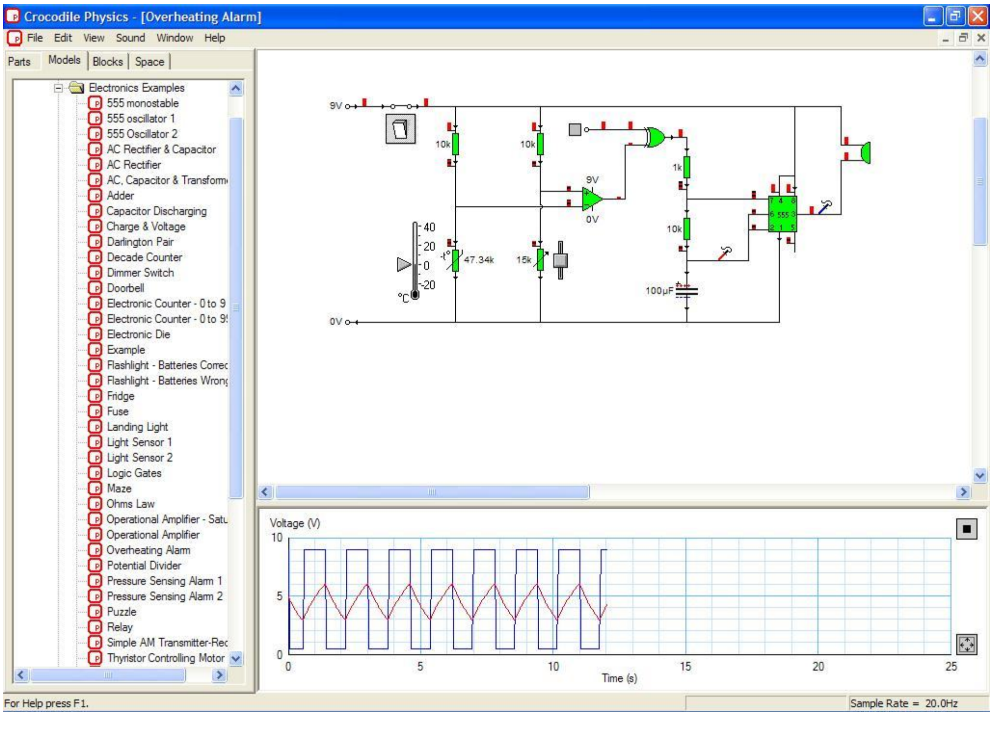

Fig. 1. A screen capture of an experiment mechanism created using the Crocodile Physics 401 virtual lab programme

As can be seen from Fig. 1, there is a menu on the left-hand side of the screen providing example models classified according to subjects, learning objects, and the possibility of arranging the experiment environment. There are short-cut buttons at the top of the screen that allow the user to make changes to the experiment mechanism (e.g., copying, deleting, locking graph on/off, print, etc.). The experimental settings in the programme can be used both as symbols and pictures. Furthermore, five different users can simultaneously use the programme on a computer network.

Users are able to select the required object from among the ones provided by the programme, move it into the experiment environment using the mouse, carry out necessary adjustments (rotating, changing values) and combine them. The experiment mechanisms have real-life features (sound, light, etc.) and the programme can create graphs (energy vs. time, speed vs. time, etc.) for the learning object selected. The programme also provides sample models and experiment sets.

Edison4: This programme was developed by the Designsoft Company, and provides a laboratory environment for electricity/electronics subjects in secondary and higher education physics curricula.

As can be seen from Fig. 2, the interface screen comprises three separate windows: the Control Panel, for making adjustments relating to the objects being used, such as adjusting the type of current; the Schema Analyser, which symbolically displays the objects selected by the user and provides the work space; and Edison, a 3D view, providing users with a working environment that looks like a real laboratory. The programme allows simultaneous use by multiple users on a computer network.

Users are able to select the required object from among the ones provided by the programme, move it into the experiment environment using the mouse, carry out necessary adjustments (rotating, changing values) and combine them. The experiment mechanisms have real-life features (sound, light,

etc.) and the programme can create graphs (energy vs. time, speed vs. time, etc.) for the learning object selected. The programme also provides animations about how to create the experiments, and allows the use of sample experiment and problem sets.

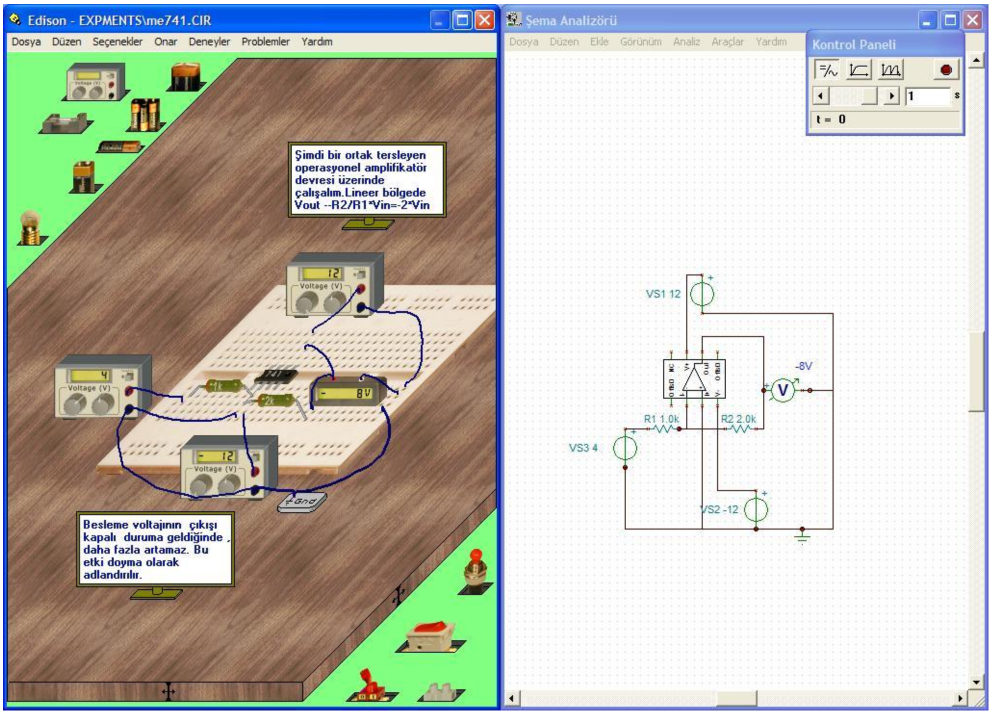

Fig. 2. A screen capture of an experiment mechanism created using the Edison4 virtual lab programme

Collection and Analysis of the Data

As in much qualitative research, the software analysis stage of the current study creates a situation partly based on interpretation. Because this significantly affects the reliability of this study, following the preparation of the analysis form, the thirteen participants forming the study group were requested to fill in the form using the software programmes. The consistency between the results of the inspection was considered to verify the reliability of the inspection (inter-rater reliability).

The scale developed for the purpose of determining the usability attributes of the virtual lab programmes was classified under three main headings, identified based on the literature review: attributes related to the interface of the software; attributes related to its use as a material in education; and attributes related to product and service support (Nikoukaran et al., 1998; Gündoğan, 2003). Two different programmes were used to evaluate the Evaluation Scale, and the attributes specified in Tables 1–3 were sought.

Table 1. Attributes of the Evaluation Scale relating to the User Interface

	Attributes
1	Can be used in the native language.
2	Can also be used in different languages.
3	Is compatible with the operating systems (Win XP, Vista, Linux, etc.).
4	Does not raise difficulties during the installation process.
5	Provides secure log-in opportunity for different users.
6	Requires extra hardware to be used (touch screen, microphone, etc.). Required hardware: ....
7	The experiment mechanisms created can be shared over the Internet and the Intranet.
8	Holds to the standards accustomed by users (Menus, symbolic icons, etc.).
9	Users have the latitude to select and use any objects they want.
11	Has an interactive structure.
12	Creates a motivating environment for the user before starting experiments (For example, asks questions about the subject or displays up-to-date experiment mechanisms.)
13	Provides users with the opportunity to run the modules again and again.
14	Provides users with the opportunity to change the values of the experiment tools.
15	Starts with the statue of being not empty. (e.g. “1 kg” for a mass selected by user).
16	Users can adjust the running speed of the experiment setting as they wish.
17	Screen arrangement is printable.
18	Provides users with the opportunity to run multiple experiments simultaneously.
19	Provides the opportunity to change the common attributes (speed, mass, etc.) of multiple experiment settings simultaneously.
20	Provides undo and redo functions.
21	Provides users with the opportunity to cancel while running.
22	Provides the opportunity to resume a previously created experiment.
23	Menus have easy-to-access location on the working environment.
24	Screen image can be copied to another environment.
25	Snap shots of the modules can be taken.

26	Has the multi-tasking feature (i.e. while a model is running, a new model can be designed simultaneously).
27	Provides interface to other software.
28	Provides auxiliary tools (calculator, etc.).
29	Supports paths such as minimum and maximum values for components (i.e. it has the bottom and top limits the objects can get in the real life).
30	Provides video-voice conference opportunity during multiple-user operation.
31	Has timelines showing the real-life duration of applications.
32	Provides the opportunity to correct an error in the experiment setting.
33	When required, inactive or broken down tools can be added to the experiment sets.
34	When broken down tools are provided in the laboratory environment, it provides the opportunity to test them.
35	Provides users with the opportunity to repair any inactive or broken down tools in the program.
36	Provides users with the opportunity to change the working environment.
37	Provides the opportunity to assign a password to an experiment setting created.
38	Some tools of the experiment setting created by users can be classified as required.
39	Has the capability to reject out-of-rule data (giving successive different commands, selecting more than one tool simultaneously, etc.) which could prevent operation of the program.
40	Has a shortcut icon on the desktop.
41	Allows use of shortcut keys (such as Ctrl+C, Ctrl+V) for rapid operation of the program.
42	Allows users to work both over the Internet and from the CD.

Remark: the answers should be ‘yes’ and ‘no’

Table 2. Attributes of the Evaluation Scale relating to the use of the virtual lab program as a material in education

	Attributes
1	It is capable of covering the curriculum of the target group.
2	The sample models match with the curriculum of the identified target group.
3	There are difficulty levels for experiments.
4	Makes curriculum recommendations to teachers for effective use.
5	Makes studying program recommendations to students for effective use.
6	Supports different teaching methods (project method, problem solving, etc.).
7	Convenient for use in group works.
8	Users are informed of their level.
9	Users can be evaluated based on their performance.
11	Users are provided immediate feedbacks.
12	Encourages users to do research (asking questions, proposing projects, etc.).
13	Experiment tools and sample experiments match with the learning and teaching attributes.

14	Contains tutorials.
15	Provides examples relating to the subject.
16	The experiment tools show parallelism with the improvements in technology.
17	Examples show parallelism with the improvements in technology.
18	Has a structure that would assist in development of creativity of students by providing the opportunity to perform experiments infinitely.
19	Allows users to manually create the graph relating to the experiment setting created (i.e. user draw the points, curves, etc. manually).
20	Combines all subjects relating to a specific field in a single module.
21	Provides the opportunity to save and load any previously performed works.
22	Has icon library. Icons can be called and run from the library and new icons can be stored in the library.
23	Provides different working environments depending on the level of users (normal, explanatory, instructive, etc.).

Remark: the answers should be ‘yes’ and ‘no’

Table 3. Attributes of virtual lab programs as a product and service support

	Attributes
1	Has help menu.
2	Provides information to users about the experiment tools and experiment environments.
3	Provides detailed information about the fields of use.
4	Provides information and evaluations about the user groups (age, school, grade, etc.).
5	Provides user’s manual.
6	Users are informed of any changes or improvements to the program.
7	Technical information can be obtained and consultancy services are provided for the program when necessary.
8	Scientific seminars are organized about the program in various places.
9	Users can send their recommendations and complaints by:: e-mail ( ) chat ( ) another method……………
	to the concerned people.
10	There is a discussion and communication platform on the Internet for the users of the program.
11	A free-of-charge trial version of the program is provided when requested.
12	The trial version can be obtained from, cd ( ) web ( )
13	Information about the program can be obtained in the Internet environment.
14	There is a 7/24 free-of-charge help line for the users of the program.

Remark: the answers should be ‘yes’ and ‘no’

The results of the evaluation performed by academics for the two virtual lab programmes using Table 1 are provided in Table 4. Accordingly, it can be seen that Crocodile Physics 401 has 61% and Edison4 59%, of the attributes listed in Table 1. Even though the reason has the most of attributes that they have for interface usability, it shows that it is needed to be developed. Attributes relating to the use of the virtual lab programmes as a material in education are shown in Table 2.The results of the evaluation performed by academics for the two virtual lab programmes using Table 2 are provided in Table 4. Accordingly, it can be seen that Crocodile Physics 401 has 57% and Edison4 54%, of the attributes listed in Table 2. Even though the programs have many attributes that are stated before, for using effectively in education, they should be developed. The attributes of virtual lab programmes in regard to product and service support are listed in Table 3.The results of the evaluation performed using Table 3 are provided in Table 4. Accordingly, it can be seen that Crocodile Physics 401 has 59% and Edison4 66%, of the attributes listed in Table 3.

Table 4. The standard deviation relating to evaluation scores

			Crocodile Physics 402				Edison4			
attributes	**Q**	**n**	**r**	**a**	**sd**	**%**				
Attributes relating to the interface	42	54	15,0	25,59	3,5	61	15,0	24,6	3,6	59
Attributes relating to its use as a material in education	23	54	16,0	13,20	3,8	57	13,0	12,4	3,2	54
Attributes relating to virtual lab programs as a Product and Service Support	14	54	8,0	8,2	2,2	59	9,0	9,3	2,2	66

Q: number of questions; n: number of participants; r: range; a: average; sd: standard deviation

Table 5. The standard deviation relating to evaluation scores

	n	**r**	**a**	**sd**
Crocodile Physics 401	54	28,0	47,0	6,4
Edison4	54	29,0	46,2	7,4

n: number of participants; r: range; a: average; sd: standard deviation

As can be seen from Table 5, Crocodile Physics 401 received an average score of 47,0 out of 79, and Edison4 46,2. In order to check the consistency of the evaluation, the results of the evaluations performed by the fifty four participants were analyzed in terms of the standard deviation and range values relating to the calculations.

Conclusion and recommendations

In this study, the usability attributes required for virtual lab programmes used in physics lessons were converted into concrete and measurable attributes using three categories – attributes related to the interface; attributes related to the programme's use as a material in education; and attributes related to product and service support – and a scale comprising 79 attributes was developed. The aim was for the scale to serve as a guide for the selection of a suitable virtual lab programme by students, teachers and school administration.

As a result of the usability evaluations performed on the basis of a full score of 79 points, the standard deviation is 6,4 for Crocodile Physics 401 and 7,4 for Edison4. This difference is considered to have arisen from the fact that the academics and teachers who evaluated the Evaluation Scale have different perspectives and skills in relation to the use of such programmes. It may be worthwhile to examine this situation with a group with broader participation.

The Evaluation Scale developed in this study can serve as a guide in the selection of a suitable virtual lab programme for teachers and education institutions who wish to use virtual lab programmes in order to achieve their

aims. Furthermore, the Evaluation Scale can act as a guide for students wishing to create experiment mechanisms and receive feedback relating to the experiments created.

Another important result observed in this study is the differences in the educationalists' skills in using virtual lab programmes. It is quite striking to observe differences even in the results obtained as a result of the evaluations based merely on Yes/No answers. Limitations have been experienced in finding individuals, who have used such software in lessons, are specialized in this field and capable of evaluating such software. It would be worthwhile to repeat the study with broader group of participants.

It is important to develop measurement tools so that educational software can achieve specific quality standards. Today, a limited number of virtual lab programmes contain a limited number of experiments suitable for a specific target audience. It would be highly beneficial to develop virtual lab programmes in line with developments in technology and education, and to update the Evaluation Scale accordingly.

The Crocodile Physics 401 and Edison4 programmes have been evaluated using the Evaluation Scale developed in this study. The evaluation of secondary education virtual lab programmes using the Evaluation Scale will aid companies developing such educational software during the design stage. This study was conducted based on the software used in a secondary education physics course. Conducting similar studies of other fields and levels is important in terms of the provision of access to evaluation scales for every field and level. Furthermore, it would be helpful to develop virtual lab programmes of a higher quality, and to determine requirements for their use in different fields and at different levels.

Limitation

In Turkey, the experts who can evaluate and use effectively virtual lab programs are not many. This limits the work group to 54 people. Because of this limitation, factor analyzing in developed the Evaluation Scale could not be realized.

NOTES

1. http://www.useit.com/alertbox/20030825.html
2. http://www.l3s.de/web/upload/documents/jensen-imej04.pdf

REFERENCES

Bateman, R.E., Bowden, R.G., Gogg, T.J., Harrell, C.R., & Mott, J.A. (1997). *System improvement using simulation*. Orem: ProModel Corporation.

Budhu, M., & Coleman, A. (2002). The design and evaluation of interactivities in a digital library. *D-Lib Magazine*, *8,* issue 11.

Ezginci, Y., Güler, İ., Özbay, Y. & Altunkaya, S. (2006). Biyomedikal Laboratuarı Eğitimine Multimedyalı İnternet Desteği. *Elektrik-Elektronik-Bilgisayar Mühendislikleri Eğitimi 3.Ulusal Sempozyumu*, EEB06, İstanbul, p. 22–25.

Galanouli, D., Murphy, C. & Gardner, J. (2004). Teachers' perceptions of the effectiveness of ICT-competence training. *Computers & Education, 43,* 63–79.

Gündoğan, M. B. (2003). Kullanılabilirlik (Usability) Kavramı ve Eğitim Teknolojileri; Yansımalar, Uygulamalar. *Proceeding of International Educational Technologies Symposium and Fair*, *I*, 642–649.

Gustavsson, I. (2002). Remote laboratory experiments in electrical engineering education. *Proceedings of the 4th IEEE International Caracas Conference on Devices, Circuits and Systems*, *Aruba*, I025-1–5.

Guzzi, R., Scarpanti, S., Ballista, G. & Di Nicolantonio, W. (2005). An educational development tool based on principles of formal ontology. *Educational Technology & Society, 8*, 80–89.

Harrell, C. R. & Tumay, K. (1995). *Simulation made easy: a manager's guide*. Norcross:: Industrial Engineering and Management Press.

Jeschke, S., Richer, T. & Zorn, E. (2001). *Virtual lab*. Berlin: DFG Research Center Matheon.

Keyhani, A., Marwali, M.N., Higuera, L.E., Athalye, G. & Baumgartner, G. (2002). An integrated virtual learning system for the development of motor drive systems. *IEEE Transactions on Power Systems*, *17*, 1–6.

Levine, T. & Donitsa-Schmidt, S. (1998). Computer use, confidence, attitudes, and knowledge: a causal analysis. *Computers in Human Behavior, 14*, 125–146.

Lin, P. I., Broberg, H. & Mon, A. (2002). A web-based lab for distance learning. *ASEE Annual Conference Proceedings,* pp. 10161-10172.

Malloy, T. & Jensen, G.C. (2001). Utah virtual lab: JAVA interactivity for teaching science and statistics on line. *Behavior Research Methods Instruments & Computers*, *33*, 282-286.

Nikoukaran, J., Hlupic, V. & Paul, R.J. (1998). Criteria for simulation software evaluation. *Proceedings of the Winter Simulation Conference*, pp. 399-406.

Noor, A.K. & Wasfy, T.M. (2001). Simulation of physical experiments in immersive virtual environments. *Engineering Computations*, *18*, 515–538.

Özdener, N. (2004). Deneysel Öğretim Yöntemlerinde Benzetişim (Simülasyon) Kullanımı, *Proceedings of 4th Congress of International Educational Technologies, I,* 239-343.

Potosky, D. & Bobko, P. (2001). A model for predicting computer experience from attitudes toward computers. *J. Business & Psychology*, *15*, 391–404.

Rozell, E.J. & Gardner, W.L. (1999). Computer-related success and failure: a longitudinal field study of the factors influencing computer-related performance. *Computers in Human Behavior*, *15*, 1–10.

Scherp, A. (2002). Software development process model and methodology for virtual laboratories. *Proceedings of the 20th IASTED International Multi-Conference 'Applied Informatics' (AI 2002)*, Innsbruck, Austria, pp. 47-52.

Serra, M., Wang, E. & Muzio, J.C. (1999). A multimedia virtual lab for digital logic design. *Proceedings of the IEEE International Conference on Microelectronic Systems Education, 19-21 July 1999*,pp. 39-40

Sanchez, J., Dormido, S., Pastor, R., Morilla, F. (2004). A Java/Matlab-based environment for remote control system laboratories: illustrated with an inverted pendulum. *IEEE Transactions on Education*, *47*, 321–329.

Subramanian, R. & Marsic, I. (2001). *Vibe: virtual biology experiment.* Piscataway: Department of Electrical and Computer Engineering and the CAIP Center.

Weissman, Z. & Yahel, R.Z. (1999). Communication courseware for college students. *Computer Physics Communications, 121–122*, 578–582.

Williams, D., Coles, L., Wilson, K., Richardson, A. & Tuson, J. (2000). Teachers and ICT: current use and future needs. *British J. Educational Technology, 31*, 307–320.

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INFORMATION TECHNOLOGIES AND MATERIAL REQUIREMENT PLANNING (MRP) IN SUPPLY CHAIN MANAGEMENT (SCM) AS A BASIS FOR A NEW MODEL

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Abstract. In this study, information technologies, one of the biggest enablers of the modern supply chain management (SCM), are discussed. Types and ways of information technologies related to supply chain management are analyzed. Material Requirement Planning (MRP), Enterprise Resource Planning (ERP), and electronic trade are discussed to provide an example.

Keywords: supply chain management, information technologies, material requirement planning, enterprise resource planning

Introduction

Information and communication technologies (ICT) are one of the most important enablers of effective supply chain management. A great deal of interest in supply chain management stems from the availability of information and the methods to analyze this information to reach meaningful results. New opportunities exist as electronic business gain importance, and es-

pecially the widespread use of internet is increasing the interest for the information technologies (Simchi-Levi et al., 2000).

Supply chain management consists of many functional areas in companies and it is affected by the communications of these groups. Thus, this paper aims to discuss the information technology structures of companies, supply chain applications and intra-company communications.

Information technologies are a source of competitive power for many companies. Especially for service industries such as big retailers, transportation companies, and airway companies where they have been started to widely used, information technologies have earned a vital role.

The time and opportunities to reach information is very important for supply chain management which aims to increase service level and decrease the costs and lead times. Along with this, many companies are offering information technologies based services to their customers in order to gain competitive edge and sustain long term relationships with them. Such a service offered by a single company in an industry makes it an obligation for the rest of the companies competing in the same industry. According to the research conducted by Subramani (2004), relationship-specific intangible investments play a mediating role linking SCM systems use to benefits. Evidence that patterns of information technology use are significant determinants of relationship-specific investments in business processes and domain expertise provides a finer-grained explanation of the logic of IT-enabled electronic integration.

The technologies used in different departments in the company differentiate from each other by the time. For successful supply chains it is vital to integrate and standardize these technologies.

Electronic trade

Electronic trade transformed the traditional, physical trade into electronic environment where there are new ways of communication between suppliers and customers. Operating an integrated supply chain requires a continuous information flow between the parties involved in the chain (Lambert & Cooper, 2004). Depending on the extent of communication network, several concepts such as *intranet, extranet, and internet* can be defined. An *intranet* is a private computer network that uses internet protocol technologies to securely share any part of an organization's information or network operating system within that organization. The term is used in contrast to *internet*, a network between organizations, and instead refers to a network within an organization. An *extranet* is a private network that uses internet protocols, network connectivity. An extranet can be viewed as part of a company's intranet that is extended to users outside the company, usually via the internet. Electronic trade is often used between the customers and companies, as well as among the companies. Shopping over the internet and checking emails are some of the examples.

After the spread of internet and acceptance of certain internet standards such as EDI (Electronic Data Interchange), electronic trade has gained importance and made the sales over the internet possible, as well as making it possible for customers to log in the database of companies and track the products. EDI is the structured transmission of data between organizations by electronic means. It is used to transfer electronic documents from one computer system to another (from one trading partner to the other). It also refers specifically to a family of standards. However, EDI also exhibits its pre-Internet roots, and the standards tend to focus on ASCII (American Standard Code for Information Interchange)-formatted single messages rather than the whole sequence of conditions and exchanges that make up an inter-organization business process.

Here are some of the advantages of the electronic trade (Simchi-Levi et al., 2000): (i) The companies and publishers gain a global existence, the choices for customers increase, and they can reach information easily; (ii) the companies increase their competitive power and service quality by making it possible for the customers to reach the services offered from anywhere and anytime. The companies can also track the customer preferences and demands on electronic environment; (iii) the companies can analyze the interest in different products; (iv) the supply chain lead time decreases. Especially for books and software products that can be provided over the internet, this is a major issue; (v) since some of the companies playing role in the distribution of the products to the customers, even the sales points in some cases are not needed anymore, there is a serious cost reduction; (vi) the small companies with the lack of resources for big investments in structure and marketing gain a chance for competition; (vii) electronic trade has resulted in an increase of electronic companies selling and distributing only over the internet. These companies can provide the customers with the products for much cheaper prices since they do not have to maintain warehouses or sales points.

On the other hand, certain barriers also exist in front of the electronic trade, namely: privacy issue; internet fraud; bad website design and service; undependable distribution and returns; competitions and conflicts among the buyers and the sellers; protection of intellectual knowledge.

Material requirement planning (MRP)

The raw material, parts and other components of the products are named as dependent demand. In order to manage this kind of demand, there is a need for a different method rather than the classical inventory management techniques.

The difference in the management of inventories stems from the difference in the structure of demand for those products. The demand for prod-

ucts such as raw materials and parts that are used in the production of final product is called dependent demand. For instance, since the demand for parts and materials required for the production of automobile depends on the amount of demand for automobile, it is classified as dependent demand. On the other hand, demand for automobile is an independent demand as it is not a component of another product.

Dependent demand exhibits a discontinuous nature as opposed to the continuous nature of independent demand. That is because certain components are used in large lots in certain periods of the production line and not used at all in other periods.

For instance, the same company might be producing different products in different periods of the year. Some parts of these products might be common in every product. Thus, the company always has to keep such components in the inventory. However, some parts are only required for certain products. So they will be needed in periods where these products will be produced, resulting in discontinuous demand for these types of parts (Sagbansua, 2006).

As a result of that characteristic, the products with independent demand should be stocked continuously, while the products with dependent demand should only be stocked just before the time they will be used in the production process. The fact that the dependent demand products are known in advance, the need for safety stock is eliminated or reduced to a minimum.

MRP is a computer-based system designed to organize the timing and ordering of the dependent demand products. The demand for the raw material and components of the final product are calculated by using the demand for the final product and it is determined how much and in what quantity to order from these components and raw material, considering the production and lead times and counting back from the delivery time of the product. Thus, the demand for the final product is used to calculate the demand for the components

in lower levels. This process is divided into planning periods and the production and assembly functions are organized, resulting in lower inventory levels along with ensuring the timely deliveries of the final product.

From this perspective, MRP is a philosophy as much as it is a technique and a time management as much as it is an inventory control method.

Ordering and timing processes were facing two difficulties in the past. The first one was the difficulty of production scheduling, dealing with the changes in the orders, and tracing many parts and components supplied by many suppliers. Due to this complexity, several policies have been proposed in the literature. Minner (2003) provides an overview of multiple-supplier models. The second difficulty was the lack of distinction between the dependent and independent demand. The techniques designed for the independent demand was being used for the dependent demand as well, resulting in high levels of inventories. Consequently, inventory planning and production scheduling were major problems for the manufacturers.

The manufacturers in 1970s have started to realize the need for a distinction between these two types of demands and different approaches to utilize for each of them. Many companies have left the record keeping and component requirements to the computers using MRP system.

MRP starts with a schedule for the final product, and this schedule is transformed into another schedule ensuring the timely delivery of the components and raw material required in the production of the final product. Thus, MRP is designed to answer three questions: What is needed? When is it needed? How much is it needed?

The inputs for the MRP system is a bill of material, a main schedule showing when and how much of the final product is needed, and an inventory records file showing how much inventory is at hand or how much is ordered. The planner determines the requirements for each planning period, using these inputs.

The outputs of the process are the planned order schedules, order confirmations, changes, performance control reports, planning reports, and exception reports.

In a discrete parts manufacturing environment, material requirement planning (MRP) is carried out without considering the manufacturing resource capacity. As a result, during implementation, adjustments in planned orders may become necessary. Pandey et al. (2000) present a finite capacity material requirements planning algorithm (FCMRP) to obtain capacity-based production plans.

Theoretically, there is no need for safety stock in the inventory systems based on the dependent demand, which is one of the main benefits of the MRP approach. After the main schedule is prepared, it is assumed that there is no need for safety stock when the managers can see the amount of usage. However, exceptions may occur in practice. For instance, variable waste ratios can cause disruptions in the operations. Moreover, the higher production times than what is expected and late deliveries of the components can also cause problems in the production process. Although the stakeholders of a supply chain make part of the same system, they take decisions which often ignore the interdependencies which in return disrupts the operations (Thomas & Griffin, 1996). It can be argued that using safety stock would eliminate the disruptions in the operations but it becomes more complex in multi-level production systems, as insufficient amount of any component will disrupt the final product production. Also, using safety stock would eliminate one of the biggest advantages of the MRP; operating without safety stock.

MRP systems deal with such problems using different methods. The goal of the managers is to find out the operations with variability and determine the extent of this variability. In situations with variable lead times, concept of safety lead time is used rather than safety stock. This concept requires to order the components to receive before the time they will be needed; thus,

eliminating the possibility of waiting for these components, or at least minimizing it. If there is variability in the amounts of components, a certain amount of safety stock can be held but the managers must carefully calculate and analyze the cost of such a safety stock. Usually, the managers choose to hold safety stock for the situations where the demand for the final product varies, and the safety lead time is not possible.

Wacker (1985) has presented a theoretical MRP model which includes both demand and supply uncertainties from quantity and timing variations. The model suggests empirical methodologies to estimate the variances of final outputs and components for estimates of safety stock requirements to reduce uncertainty. Wacker suggests a methodology for safety stock estimates to alleviate demand uncertainty for trade-to-stock organizations and made-to-order organizations. He also suggests methodologies to estimate safety stock for the production systems to alleviate supply uncertainty.

The managers must be sure of the lead times especially when the components are expected to reach the production point just before they will be used. The early component entries would be increasing the current inventory levels, while the late entries would delay the other operations, resulting in important losses and extra costs. Considering this fact, the managers choose to show the lead times longer than they are, accepting certain amounts of early entries.

Choosing a lot size for orders or production is an important issue both for the dependent and independent demand products. Usually, the economic order quantities and economic production quantities are used to the independent demand products, whereas many different methods are used for the dependent demand systems, stemming from the fact that no method exhibits an obvious advantage over the others (Taha, 2006).

The priority of the inventory management for both of the demand types is minimizing total of the ordering and holding costs. The independent

demand exhibits an even distribution during the planning horizon while the dependent demand has a more intermittent structure and a shorter planning period. Thus, it is more difficult to calculate economic lot quantities.

Anderson et al. (1981) report on a simulation study of hierarchical planning methods, which can be utilized in connection with material requirements planning. The company considered produces one final product having a complex structure. The factory is functionally organized. Two different cases have been studied. In the first case there were both seasonal and independent stochastic variations in demand and in the second case only stochastic variations.

A simulation experiment that compares alternative procedures for determining purchase quantities in MRP systems when quantity discounts are available, is reported by Benton (Benton & Whybark, 1982).

MRP has many benefits both for production and assembly operations. Some of these benefits are listed here: low levels of in-process stocks, a possibility to track the component needs, a possibility to evaluate the capacity requirements suggested by the main schedule, a possibility of distributing the production time. The conditions required to successfully and efficiently utilize and use the MRP system are: computers and software should maintain the records and execute the calculations; computers should be accurate and updated together with integrity of the information (main schedules, bill of material, inventory records).

Enterprise resource planning (ERP)

ERP is a system originated from the need for the integration of the standardized record-keeping to enable the information sharing between different units of the companies. It responds to the needs of all these units by linking all units and functions in the company to a computer system.

A wide range of software to serve the employees in every unit is required. In fact, every unit possesses its own computer system and these systems are designed to enable these units to execute their duties at a maximum level. ERP enables the information sharing of all units and communication with each other by bringing all of these systems in an integral software program supported by a common database.

Conclusions

The traditional purchasing and logistics functions have evolved into a broader strategic approach to materials and distribution management known as supply chain management. Information technologies as one of the biggest enablers of the supply chain management, is discussed in this research. Types and ways of information technologies related to supply chain management such as electronic trade, MRP and ERP are among the examples provided.

Many employees are using the information provided by MRP in manufacturing companies with this system. Production planners, production managers, customer service representatives, purchasing managers, and inventory managers are some of them. The benefits of the MRP system depends heavily on the availability of the usage of computers which will maintain updated data about the component needs.

Accuracy has a vital role in a successful MRP system. The mistakes in inventory records or bill of material would result in missing parts, over-ordering of some products and under-ordering of others, deviations from the production schedule, all of which cause bad results such as low level of customer service, inefficient use of resources, and untimely deliveries to the customers. Moreover, MRP system can be difficult to utilize and expensive. Thus, the companies planning to use this system must carefully evaluate the benefits and the necessities of MRP.

Electronic trade has eliminated the barriers to do business internationally. Even the small companies have started to compete in international markets. The developments in communication and transportation industries are the main enablers of this trend. The companies can market their products to the customers anywhere in the world over the internet. The customers also benefit from the developments by gaining access for more information and product alternatives.

Future research will be conducted to introduce an MRP model for multi-echelon inventory systems and include the experimental results of the model utilization.

REFERENCES

Anderson, H., Axsäter, S. & Jönsson, H. (1981). Hierarchical material requirements planning. *Intern. J. Prod. Res.*, *19*, 45-57.

Benton, W.C. & Whybark, D.C. (1982). Material requirements planning (MRP) and purchase discounts. *J. Operations Management, 2,* 137-143.

Lambert, D.M. & Cooper, M.C. (2000). Issues in supply chain management. *Industrial Marketing Management, 29,* 65-83.

Minner, S. (2003). Multiple-supplier inventory models in supply chain management: a review. *Intern. J. Prod. Economics, 81-82,* 265-279.

Pandey, P.C., Yenradee, P. & Archariyapruek, S. (2000). A finite capacity material requirements planning system. *Production Planning & Control, 11,* 113-121.

Sagbanşua, L. (2006). *Supply Chain Management.* EU Entrepreneurship Support Publishing [In Turkish].

Simchi-Levi D., Kaminsky, P.& Simchi-Levi, E. (2000). *Designing and managing the supply chain.* New York: McGraw-Hill.

Subramani, M. (2004). How do suppliers benefit from information technology use in supply chain relationships? *MIS Quarterly*, *28 (1)*, 45-73.

Taha, H.A. (2006). *Operations research: an introduction.* Upper Saddle River: Prentice Hall.

Thomas, D.J, Griffin, P.M. (1996). Coordinated supply chain management. *European J. Operational Research*, *94*, 1-15.

Wacker, J.G. (1985). A theory of material requirements planning (MRP): an empirical methodology to reduce uncertainty in MRP systems. *Intern. J. Prod. Res.*, *23*, 807-824.

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ОТ СРЕДНОТО УЧИЛИЩЕ КЪМ ТЕХНИЧЕСКИЯ УНИВЕРСИТЕТ – ИЛИ ЕДНА ТРУДНА ГОДИНА ЗА СТУДЕНТИТЕ-ПЪРВОКУРСНИЦИ

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Резюме. Преходът Училище – Университет е проблемен период, свързан с различни промени и трудности за повечето първокурсници в различните висши училища. Липсата на навици за самостоятелна учебна подготовка и нестабилната основа от знания и умения за овладяване на учебния материал по математика на по-високо ниво, от една страна, както и различната организация на учебния процес от друга страна, водят до сериозни трудности. Част от първокурсниците не знаят какво точно знаят и какво трябва да знаят. Не им е ясно защо трябва да учат учебни теми на определено ниво, а и не знаят как да учат това, което би трябвало да знаят. Настоящата статия е опит за класификация на ключовите проблеми и евентуалните причини и източници за тяхното възникване в учебния процес по математика в техническите висши училища. Посочен е комплекс от мерки, които биха способствали за преодоляване на проблемите в този преходен период. Резултатите се базират на проучване на чуждестранния опит, както и на анкета и проведени разговори с преподаватели от такива университети. Считаме,

че с малки разлики и допълнения обсъжданите проблеми са общи за повечето институции на висшето образование, където се преподава висша математика като базова, но спомагателна дисциплина.

Keywords: mathematics education, transition secondary – tertiary degree, mathematics support, diagnostic testing, teaching and learning process

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Преходът "Училище – Университет" е проблемен период, свързан с различни промени и трудности за повечето първокурсници в различните висши училища. Част от тези трудности произтичат от необходимата адаптация към един нов етап от техния живот. Много от младите хора имат неясни представи за собствените си професионални и личностни наклонности и възможности. Голяма част от тях не осъзнават съществените разлики в отговорностите и правата между ученик и студент. Липсата на навици за самостоятелна учебна подготовка и нестабилната база от знания и умения пораждат сериозни трудности. При някои студенти има сериозни разминавания между оценките по математика и физика в училище и от матурите. Налице е обърканост и несигурност в новата студентска обстановка, съчетана със слаби оценки в първите сесии. Обобщено начинаещите студенти: (1) *не знаят какво знаят* – налице е сериозно разминаване между самооценка и реални знания. Обучаемите не са наясно с характера и дълбочината на своите пропуски и частични знания по математика. Дори да осъзнават, че имат проблеми, те не могат да преценят доколко това е сериозна пречка в учебния процес; (2) *не знаят какво трябва да знаят* – не са наясно с минимума базисно знание, върху който биха могли успешно да надграждат новите знания; (3) *не им е ясно защо трябва да учат точно този учебен материал* – не осъзнават значението на математическите методи за инженерните дисциплини и връзката между тях; (4) *не знаят*

как да научат това, което трябва да знаят – повечето от тях механично наизустяват понятия и алгоритми без да вникнат в тяхната същина и идеи и без да осъзнават връзката между различните теми.

Посочените проблеми и трудности в учебния процес са констатирани както в редовните часове и консултации по Математика за I курс, така и в анкета и разговори със студенти и преподаватели от технически висши училища. Считаме, че с малки разлики и допълнения, тези проблеми са общи за всички висши училища, в които математиката се преподава като основна учебна дисциплина.

Кратък литературен преглед

Огромен брой конференции, статии и обзори от цял свят са посветени на горните въпроси. От една страна университетски преподаватели и ръководни кадри са единодушни в безпокойството си, че в последните две десетилетия е налице сериозен спад в знанията на първокурсниците. От друга страна инженерните науки се развиват с бързи темпове и никой не поставя под съмнение необходимостта от задълбочени математически знания. Разнообразни стратегии, проекти и планове се дискутират и експериментират на различни нива - международни, национални и университетски. Независимо от предприетите мерки и частичните положителни резултати, проблемът остава нерешен и изключително сериозен (Банков, 2007a; Croft, 2002; de Guzman et al, 1998; Kitchen, 1999).

През 1995 год. Лондонското математическо дружество (LMS)[1)] съобщава за безпрецедентен спад в предварителната подготовка на първокурсниците. Четири години по-късно LMS отново изнася тревожни факти за устойчивия спад в знанията по математика. Sutherland & Pozzi (1995) докладват, че мнозинството от лекторите в инженерните университети на Обединеното кралство наблюдават сериозен упадък в

математическите знания на новите студенти. Според заключенията на Sutherland & Dewhurst (1999) училищните учебни планове и програми не помагат за адекватната математическа подготовка – чрез тях нито се достига необходимото ниво, нито се усвояват нужните знания и умения по математика и физика. Преподаватели от различни технически висши училища споделят подобни виждания на различни научни форуми - Мишколц (2000), Гьотеборг (2002), Виена (2004), Конгсберг (2006), на европейските семинари по математика и инженерни науки - SEFI MWG. Сериозните постижения на българските ученици на международни състезания по математика са много над средното ниво на българските кандидат-студенти в техническите университети.

Банков (2007b) прави анализ на резултатите от международните изследвания на TIMSS-2007 за световните тенденции в масовото обучение по математика и природни науки в 8 клас. Такива проучвания в България са правени през 1995, 1999, 2003 и 2007 год. Според TIMSS-1995 страната е на 9-то място по математика и на 5-то място по природни науки, следват 17-то и съответно 16-то място през 1999 год., за да се достигне 25-то и 24-то място през 2003. Резултатите през 2007 год. ни поставят значително под международната средна стойност. Сривът в знанието на нашите ученици е повече от тревожен.

Изясняване на основните проблеми и причините за тяхното възникване

Учебната среда е изключително сложен комплекс от динамични и многообразни компоненти: (i) *учебно съдържание*, което трябва да се преподава по утвърден учебен план и зададена учебна програма, за да се постигнат определени учебни цели; (ii) *преподаватели,* върху които влияят много фактори – условия на живот, работни условия, предварителни знания, умения, опит, цели, желания и

т.н. Преподавателската работа е творческа и емоционалните фактори имат голямо значение; (iii) *студенти*, върху които също влияят изключително много фактори – както по-горе изброените, така и наличният фундамент от знания и умения по математика, навици за самостоятелна работа, ясно поставени цели; системност и упоритост в учебния процес и др.

Организация на учебния процес в съответния университет - *особености в обучението по математика* - *организация на обратната връзка в различните етапи на учебния процес* - всеки един от тези компоненти има важна роля в учебния процес и би могъл да бъде източник на проблеми. Различните автори търсят и групират по различен начин основните източници на проблеми в учебния процес по математика. Според de Guzman et al (1998) три са основните източници за трудностите в преходния период Училище – Университет: епистемиологични и когнитивни, социологични и културни и дидактически.

С масовизацията на висшето образование (Димитров & Тошев, 2001) посочените до тук проблеми се изострят в значителна степен, защото в системата на висшето образование постъпват студенти, мястото на които не е там, а висшите училища се опитват да ги задържат, вместо да се освободят от тях, по финансови причини. Така проблемите в преходния период са резултат от разширяване на достъпа до висше образование и недостатъчна подготовка по математика в училище. Последната е налице поради различни недостатъци на учебните програми, акцентиране върху оценките, недостиг на квалифицирани учители и негативни социални влияния.

По наше мнение *източниците на съществуващите трудности* в учебния процес са:

(А) ***Общо организационни*** - свързани с организацията на учебния процес – 1) нехомогенни групи, които затрудняват преподавателите при определяне темпа и нивото на работа; 2) несъгласуваност на програмите по различните курсове в учебния процес; 3) недостиг на съвременни учебни средства – мултимедия, интерактивни дъски и др.; 4) малко на брой зали, оборудвани с компютри и снабдени с подходящ софтуер.

(Б) ***Некачествена база знания и умения на студентите*** – 1) *частично изградена и непълна понятийна система* (критерий за добре изградено понятие е не да се знае името му, а в режим на работа да се класифицира новата информация (Skemp, 1987)). Липсата на основни знания и умения от цели раздели на училищния курс, напр. Тригонометрия, е сериозна пречка, която е невъзможно да се преодолее в редовните занятия. Според Skemp (1987) понятийната система е резултат на човешките способности да обединяват и свързват различен опит и класове от опит. Понятийното мислене дава възможност за адекватни реакции към конкретните проблеми, за сравняването им с необходимите условия и прогнозиране на очакваните резултати. Усвояване на «голи» факти, без да се изучава необходимата за това теория не може да произведе добри резултати. Само подходящата теория дава възможност за обяснение, предвиждане и контролиране на голям брой отделни въпроси и събития от клас, към който те принадлежат. Многобройните термини, понятия и факти, които не са свързани в понятийна система не могат нито да бъдат запомнени дългосрочно, нито да се използват ефективно; 2) *неточно или грешно заучени понятия* - неумението да се учат точно и коректно определенията води до различни грешки, свързани с понятията абсолютна стойност, логаритъм, функция, неразпознаване на елементарните функции, на основни видове уравнения и неравенства, изучавани в учебния курс; 3) *незнание на*

основни термини и неумение да се ползват - част от учащите не знаят какво е ***1*** rad, факториел, труден им е прехода градуси – радиани; 4) *лоша изчислителна техника* - студентите успешно усвояват голяма част от задачите от линейната алгебра - умножение на матрици, изчисление на детерминати, определяне ранг на матрици, обратни матрици, решаване на системи. Това, което им пречи да решават докрай вярно задачите, са изчислителните грешки дори и с цели числа. Грешките от аритметични действия с дроби, степенуване, коренуване и логаритмуване се пренасят в задачи от диференциалното и интегрално смятане. Част от студентите се затрудняват при използване на формули за съкратено умножение или при решаване на квадратни уравнения при наличие на ирационални числа или при смяна на използваните букви. Задачи като посочените по-долу затрудняват не малка част от учащите: $\left(\sqrt{2}\pm\sqrt{3}\right)^2$, $\left(\sqrt[3]{2}\pm\sqrt[3]{3}\right)^3$, $\sqrt{2}s^2-3s-\sqrt{3}=0$; 5) *непълно, неточно или грешно научени формули и алгоритми* - грешки от вида $x.\frac{1}{x}=0$; $\frac{a}{b+c}=\frac{a}{b}+\frac{a}{c}$; $\lg\left(x\pm y\right) \quad \lg x\pm\lg y$; $a^0=0$ се коригират много трудно. Те водят до груби грешки при решаване на уравнения, неравенства и системи. Съчетани със затрудненията, които предизвикват решаването на основни показателни, логаритмични и тригонометрични уравнения и неравенства, такива грешки водят до невъзможност за изследване на функции, пренасят се и в интегралното смятане; 6) *механично заучени теореми, алгоритми и готови схеми без логическа обосновка* - почти винаги теоремите се прилагат директно, без проверка на условията, гарантиращи тяхната вярност. Среща се дори замяна на условието със заключението на теоремите; 7) *неумение за вербален израз на уменията, които студентите притжават* - при вярно решена задача, студентите не могат да обяснят решението, като отговорът е: „разбирам решението на задачата, но не мога да го обясня"; 8) *трудност*

при разбиране на т.н. „текстови задачи”; 9) *неумение да се разчита информация, зададена по различни начини* – графично, символно, аналитично и от един начин да се записва в друг - повечето студенти се затрудняват да начертаят графиката на дадена функция, дори при получени верни резултати от нейното изследване. Част от тях се затрудняват да коментират свойствата на функция при дадена нейна графика. Преходът $|x| > M,\ M > 0 \Leftrightarrow (x > M) \vee (x < -M) \Leftrightarrow x \in (-\infty, -M) \cup (M, \infty)$ или $|x| < \varepsilon \Leftrightarrow -\varepsilon < x < \varepsilon \Leftrightarrow x \in (-\varepsilon, \varepsilon)$ затруднява не малко студенти; 10) *хаотично изградена и неосъзната понятийна система,* което води до неосъзнаване на връзките между понятията в една и съща област (вътрешнопредметните връзки) и до неумение за пренос на знания и умения от една област в друга.

(В) ***В техническите висши училища е налице качествено ново ниво на математическата теория и нейното усвояване:*** 1) при прехода от училище в инженерен университет е *налице огромен понятиен скок, който трябва да с постигне в кратък отрязък от време.* Той е свързан не само с много нови теми, които трябва да бъдат овладени, а и с различни технически умения и процедури, свързани с новите понятия и най-вече с по- задълбочен и абстрактен начин на мислене. В училище много от новите понятия се въвеждат интуитивно, широко се използва геометрично онагледяване и изчислителната интерпретация. Понякога се стига до другата крайност - интуитивните и изчислителни съображения в някои задачи не само подпомагат логическото обосноваване, но и го изместват изцяло. Доказателството на някои теореми се прави формално и не се обръща внимание на типа доказателство и на близки теореми и задачи, където успешно би могло да се използва. Почти всички ученици, които са изучавали математика – I

ниво, а и много от II ниво, не са запознати с различните методи на математически доказателства. Много от студентите не правят разлика между необходимо условие, достатъчно условие, необходимо и достатъчно условие. Те се затрудняват да съставят отрицанието на дадено твърдение. Не са единични случаите, когато не се прави разлика между условието и заключението на теорема. Житейската логика се различава от математическата логика и обучаемите трябва съзнателно да бъдат обучавани в тази насока; 2) *преходът от примери и чертежи към формални дефиниции на нови понятия и логически доказателства, включващи преобразувания със символи е изключително труден.* За повечето ученици, привикнали да мислят конкретно, преходът към абстрактно и логическо мислене е непосилен. За да бъде успешно преподадена една тема по математика е необходимо: новите знания да съответстват на нивото на наличните знания, т.е. да има плавно надграждане, а не скок, включващ много непознати понятия и умения; начинът на въвеждане на новата тема трябва да съответства или плавно да надгражда тренираните мисловни модели на обучаемите; да има непрекъснати усилия за постепенно нарастване на аналитичните възможности на учащите се до ниво на независимост от техните преподаватели. За да бъде успешен един преподавател по математика той трябва да учи своите ученици не само на математика, но и как се учи математика (Skemp, 1987); 3) *неизградени учебни навици и липса на интелектуални умения* - неумение и нежелание, дори страх да се мисли самостоятелно. Повечето студенти (с малки изключения) са свикнали да повтарят буквално преподадената информация, да извършват механично необходимите действия без да се стараят да ги осмислят. Еднотипните примери, липсата на контрапримери са в основата на тези „вредни” навици; неумение и нежелание да се учи самостоятелно - за съжаление, колкото и нелогично да звучи - между преподаването и знанието липсва

много важна връзка – ученето, самоподготовката; неумение да се водят записки - много от студентите не могат да разграничат съществената от несъществената информация (освен ако преподавателят изрично не я посочи) и се опитват да запишат почти всичко. Повечето от тях не умеят да съкращават думите и да ползват символи. В повечето сайтове на техническите университети има „качени” много малко лекции и упражнения. Приятно изключение са учебниците и сборниците по математика в сайта на Университета по архитектура, строителство и геодезия в София. В крайна сметка часовете по математика се превръщат в часове по писане за студентите и преподавателите. Няма дискусии - има монолог; *неумение да се ползват справочници*; *неумение да се работи в екип; желание да се работи епизодично, на парче или само преди изпита* - тези желания се поощряват от липсата на текущи тестове, контролни и курсови работи през семестъра.

(Г) ***Качествено нова организация на учебния процес:*** 1) *различие в методите и темповете на преподаване в училище* - преподавателят преподава темите изключително бързо; на всяко занятие се преподават огромни порции нов материал; сравнително малък брой упражнения за овладяване на новия материал; неумение или нежелание да се обоснове необходимостта от изучаване на конкретната тема, т.е. да се мотивират студентите; неумение или нежелание за създаване на творческа обстановка в час; пасивна роля на студентите по време на часовете; 2) *ниска мотивация и ангажираност както на студенти, така и на преподаватели* - различни са корените на този тежък проблем. Вина за това носят както студенти и преподаватели, така и липсата на адекватни мерки за промяна в организацията на учебния процес. Студентите не са убедени, че математиката, която присъства в тяхното университетското образование, развива техния потенциал за бъдещата им професионална

квалификация. От друга страна преподавателите не съумяват да убедят студентите в това. Единствената заплаха е предстоящата сесия, но за съжаление това не е достатъчна мотивация. Много от студентите не осъзнават важността на математическите знания и умения в изучаваните инженерни дисциплини. Част от преподавателите имат бегла представа за конкретните приложения. Няма интерес за сформиране на екипи от математици, физици и инженери за обща програма, за включване на подходящи примери в учебния процес. Нещо повече, няма дори координация в учебните програми. Например: в първи курс, I семестър, студентите използват интеграли във физиката, диференциални уравнения в електротехниката, а месеци след това ги учат в часовете по математика. И това не е единственото разминаване. Към това се добавя начинът на преподаване, който отрежда пасивна роля на студентите и „наливането на информация”. Намаляването на часовете за лекции и упражнения без да бъде съкратен преподавания материал е предпоставка за непрекъснато бързане, за липса на доказателства. Ненадежната база знания, основните пропуски и неумението да се учи самостоятелно действат демотивиращо. В университетите няма нужната организация за подпомагане на студентите за разрешаване на тези техни проблеми. Консултациите и интернет материалите не са на нужното ниво за да бъдат надежно помощно средство. За съжаление една сериозна алтернатива на закъсалите учащи се явяват частните уроци. Така се получава един порочен кръг - за да се набере нужният брой студенти се намаляват изискванията по приема. Обучението на част от първокурсниците изисква допълнителни усилия и от двете страни за да има нормален учебен процес. За съжаление такива усилия няма или са крайно недостатъчни и за да се разреши проблема „се сваля летвата” на изпитите през сесиите. На каквото и високо ниво да се преподава, ако крайният изпит не съответства на това ниво, студентите нямат

мотивация да го покрият. Липсата на контрол и обратна връзка през семестъра също влияе демотивиращо. Възможността за явяване на един изпит многократно без никакви санкции също е демотивиращ фактор. Малко от младите хора осъзнават, че трябва да контролират процеса на собственото си израстване както в личностен, така и в професионален план.

(Д) ***Различие в целите, а оттам и в методите на преподаване по математика*** - нито преподавателите, нито студентите оспорват изучаването на математика в техническите висши училища. Същественият въпрос е да се определи *съдържанието на необходимите математически теми и нивото на което те да бъдат преподавани,* т.е. балансът практически приложения и разбиране в дълбочина. Битуват почти противоположни мнения за целите, а оттам докъде и как да се преподава. Компютърно базираното обучение, компютърните тестове за самооценка и изпити се използват широко в обучението по математика в много от чуждите университети (Hughes-Hallett, 1995; Habash et al, 2006). Все още мненията на преподавателите у нас, както за организацията на часовете, така и за ролята на програмните продукти и уеб-базираното обучение, изглеждат противоположни. За да бъде проучено мнението на преподавателите по математика за различните проблеми и тяхното преодоляване беше проведена следната анкета.

Анкета с преподаватели по математика в български технически висши училища

Цел: изследване на отношението на преподавателите по математика към проблемите, свързани с обучението на студентите от I курс на техническите висши училища; проучване на техните мнения за организацията на учебния процес и препоръките за евентуални промени.

Инструментариум: Разработената анкета съдържа 78 подвъпроса, разпределени в 11 въпроса по *три* направления, засягащи приема на студенти в техническите висши училища, проблемите на първокурсниците и организацията на учебния процес по математика. Част от въпросите са подвъпроси на предишни въпроси и имат за цел доуточняване мненията на преподавателите към констатирани слабости в предварителната подготовка на студентите, целите и организацията на процеса на обучение по математика в техническите университети. Към всеки въпрос има оставени празни редове за допълване с мнения, различни от дадените. Въпрос 7 е за наличието/отсъствието на координация между курсовете по математика и другите изучавани дисциплини. При съставяне на въпросника е използвана скалата на Ликерт с пет степенна бална оценка на предварително предложени твърдения. Заложени са следните оценки: абсолютно съм съгласен (5), съгласен съм (4), колкото съм съгласен, толкова и не съм съгласен (3), не съм съгласен (2), абсолютно не съм съгласен (1).

Въпроси	**Категория**
1 - 6	Прием в Техническите Университет
7 - 15	Проблеми в преходния период, т.е. I курс
16 - 24	Предварителна подготовка на студентите
25 - 38	Преодоляване на учебните проблеми
39 - 45	Използване на иновационни методи
46 - 55	Учебна подготовка на студентите
56 - 63	Ниво на което трябва да се преподава математика
64 - 71	Повишаване мотивацията на студентите
72 - 77	Цели на обучението по математика

Респонденти: Анкетата е предложена на 48 преподаватели от технически университети, но осем преподаватели не бяха отговорили на всички въпроси и техните анкети бяха игнорирани. Разглежданите резултати са получени чрез пряко анкетиране на 40 преподаватели по математика от Техническите университети (ТУ) в София и Пловдив и

Химико-технологическия и металургичен университет (ХТМУ) - София, от които 20 са хабилитирани и 20 - нехабилитирани. Между хабилитираните преподаватели има двама професори и 18 доценти, а разпределението на нехабилитираните преподаватели по длъжности е както следва: асистенти (4), старши асистенти (4) и главни асистенти (12). Преподавателите са мъже (18) и жени (22). Разпределението им по стаж е дадено в долната таблица.

стаж	0-5 г.	5-10 г.	10-15 г.	15-20г.	20-25 г.	25-30г.	30-35г.	35-40г.
хабилитирани	0	0	0	0	1	1	8	10
нехабилититирани	2	2	2	2	4	4	4	0

Забележка 1. Имайки предвид спецификата на разглежданите въпроси и отношението на анкетираните като специалисти, бихме могли да разглеждаме техните мнения и оценки като **„*експертни*”.** Всеки един от анкетираните колеги има около 200-500 „реални” учебни часа годишно със студенти от първи курс в различни факултети на техническите университети.

*Забележка 2***.** Аргументите за и против при някои от въпросите, както и колебанията между категорично и некатегорично съгласие/ несъгласие, са породени от разликата в знанията на студентите в различните факултети.

Забележка 3. Получените резултати бяха подложени на различни методи на обработка от клъстърния анализ, но получените резултати не бяха оценени задоволително от авторите. Сравнително малкият брой анкетирани лица наложи получените резултати да се разглеждат в проценти. Превес в тази насока даде и обработката на подобни анкети (de Guzman et al., 1998; Jourdan et al., 2007). Вземайки предвид колебанието между категоричното и некатегорично съгласие или несъгласие, отговорите бяха трансформирани към три степенна бална

оценка: положителна нагласа (съгласие), условно неутрална (с аргументи както за, така и против) и отрицателна нагласа (несъгласие) с даденото твърдение.

Забележка 4. Резултатите на всички анкетирани бяха обработени на I етап заедно и основно те ще бъдат коментирани. На II етап бяха разгледани поотделно анкетите на хабилитирани и нехабилитирани преподаватели с цел да се видят проблемите под различен ъгъл – лекции и упражнения.

Справка: Минимални балове на I и II класиране към ТУ-София за учебната 2009/2010 г. (Първи приемен изпит: 12 юли 2009 г.; Втори приемен изпит: 13 август 2009 г.)

Специалности	12 VII	13 VIII
Машинно инженерство, енергетика, транспорт и авиация	16.65	14.00
Електротехника и автоматика	18.30	16.80
Комунакиционна, компютърна и електронна техника	21.53	20.33
Публична администрация	21.88	20.47
Стопанско управление	22.72	21.05
Приложна математика	20.70	19.18
Компютърни системи и технологии (на немски език)	21.70.	19.53
Индустриален мениджмънт	21.00	19.62
Инженерен дизайн	19.00	17.87
Индустриално инженерство (на английски език)	19.75	17.82
Общо машиностроене (на немски език)	16.33	16.33
Елктроинженерство (на френски език)	15.02	15.23

Резултати

Според настоящата анкета (Приложение) 80% от преподавателите считат, че матурата не е достатъчно сериозен изпит за влизане в техническо висше училища, а според 18% това е възможно, но с определен коефициент на редукция. Колкото до кандидат-студентския

изпит мненията се разрояват – 30% одобряват нивото, 33% се колебаят с аргументи и в двете посоки, а 38% считат, че има принизени изисквания. 93% от анкетираните се обединяват около мнението, че университетите умишлено свалят нивото на кандидат-студентския изпит, за да бъде приет нужния брой студенти. 85% от преподавателите считат, че първата година е трудна за новопостъпилите студенти и «критична» за тези, които са приети с по-нисък бал. 48% от преподавателите признават, че във висшите училища не са създадени необходимите условия за усвояване на липсващите знания и за подпомагане на нуждаещите се студенти.

Интересно е разпределението на мнението по 7-ми въпрос: само 23% считат, че недостатъчно се използват съвременни средства за обучение; 48% с известни уговорки и според 30% - съвременните средства са достатъчни. За сведение – с малко изключения както лекциите и упражненията, така и изпитите по математика се провеждат по традиционен начин.

Преподавателите са критични към организацията на учебния процес и не считат, че само студентите са виновни. Само 25% от тях считат, че студентите не полагат нужните усилия, а учебният процес е на ниво, според 58% има какво да се прави от обучаеми и обучаващи, а 18% са на мнение, че трябва по-добра организация на учебния процес. За 83% от преподавателите има несъответствие между учебен материал и брой часове, за които трябва да се предаде. Различната организация на учебния процес в училище и в университета е сериозен проблем според 70% от преподавателите.

Слабата предварителна подготовка на студентите (85%), липсата на навици за самостоятелна работа (83%), отсъствията от лекции и упражнения (75%), ниската мотивация и ангажираност (63%**),**

недостатъчната упоритост, постоянство и инициативност (58%) са сериозни причини за проблемите на първокурсниците.

Слабата предварителна подготовка на студентите според преподавателите се изразява в: а) частично изградена и непълна понятийна система - 75%; б) неосъзнати връзки между понятията - 73%; в) неумение да се разчита информация, зададена графично, аналитично, символно - 58%; г) неувереност и страх от самостоятелна мисловна дейност – 58%; д) неточно, непълно или грешно научени алгоритми - 55%; е) лошата изчислителна техника (48%) и неточно или грешно заучените понятия (40%) също са проблемни при първокурсниците. 25% от преподавателите по-скоро не са съгласни, че проблемите в първи курс се дължат на неточно или грешно заучени понятия или на недобра изчислителна техника.

85% от преподавателите считат, че предварителната подготовка на студентите е слаба. За преодоляване на този сериозен проблем са предложени различни решения, които се оценяват по следния начин: 95% от преподавателите предлагат увеличение на броя на часовете за упражнения и 55% - съответно за лекциите. 80% желаят по-високо ниво на кандидат-студентските конкурси, а 73% считат, че предварителен дву-три седмичен курс по математика ще помогне за преодоляване на проблемите на първокурсниците, приети с по-нисък бал.

Мненията се раздвояват за курсова работа след всеки раздел, както и да се промени оценяването – за груби грешки да се отнемат точки. Едва половината преподаватели виждат смисъл в задължителните домашни работи (55%**),** въвеждането на контролни тестове след всяка тема (53%**),** курсовата работа след всеки раздел (43%). Причините са прагматични – от една страна допълнителни усилия за съставяне на тестове, домашни и курсови работи и тяхното проверяване, а от друга - евентуално преписване на студентите. Само 25% подкрепят уводните

тестове, а 23% - задължителните консултации при установени сериозни пропуски. Причините са в допълнителното натоварване на преподавателите, чийто труд е заплатен твърде ниско. Използването на иновационни методи се оценява положително от 48%; 28% ги приемат с определении резерви, а 25% не ги одобряват. Изграждането на центрове за учебна помощ, подобни на съществуващите в някои европейски, американски и австралийски университети (Croft, 1999), се одобрява от около 60% от нашите преподаватели, 12% ги приемат с резерви, а за 28% те няма да бъдат от полза.

Във всички етапи на обучението по математика – както в средното, така и във висшето образование – при преподаване на нов материал, в самостоятелната подготовка и в различните тестове и изпити, различни програмни продукти се използват широко в развитите в технологично отношение страни. В българските технически университети има много неясноти, съмнения и колебания в тази насока.

85% от преподавателите не са използвали примери от други дисциплини в своите лекции или упражнения и не са наясно дали има разминаване в учебните планове при изучаване на съответните теми. 15% се опитват да мотивират своите студенти, давайки примери от други дисциплини и са правили неуспешни опити за координиране на учебните програми.

Мнението на преподавателите за основните фактори, на които разчитат студентите за изпитите по математика, буди тревога: късмет (70%)**,** преписване от колеги (63%), използване на „пищови”, GSM, SMS и други нерегламентирани средства - (63%). Само 5% отхвърлят тези възможности. Оформянето на оценката по математика само от крайния изпит опростява работата на преподавателите, но има други неблагоприятни ефекти – дава възможност на студентите да не се подготвят за всяко занятие, а да чакат сесията. Тази липса на оценка по

време на семестъра и оценяване само от крайния изпит без ясни критерии не е „доброто” решение за обратна връзка.

Силно обезпокояващо е мнението на анкетираните за евентуалните източници за подготовка на студентите – основно записки от лекции и упражнения - собствени (68%) или на техни колеги (50%). Студентите не ползват материали от Интернет според 65% от колегите, само 13% смятат, че това е възможно. Аналогично, само 13% считат, че студентите разчитат на консултации в подготовката за изпитите, а 50% не са съгласни с това твърдение. Около 30% вярват, че студентите използват учебници и сборници в подготовката за изпит и почти толкова – 28%, че това не се случва. Противоположни мнения се оформят и при въпроса дали студентите разчитат на частни уроци в подготовката за изпит. Според 25% - да, други 25% - не, а 50% са без мнение.

Мотивацията на студентите се свързва основно със създаване на творческа обстановка според 90% от преподавателите. Но как да се реализира? Това е сложен комплекс от много компоненти – умения на преподавателите, желание на студентите, време и база за реализация. Като успешни възможности в тази насока анкетираните посочват: разяснения къде и как този учебен материал ще им трябва - 78%, решаване на подбрани приложни задачи - 75%**,** въвеждане на нови методи и средства - 58%.

Отношението на студентите към една или друга дисциплина зависи не само от нивото на преподаване, но и от организацията и нивото на контрол. Преподавателите отчитат тези фактори: 88% от тях залагат на сериозни контролни работи и изпити; за 85% крайните оценки трябва да зависят не само от крайния изпит, а и от други компоненти - участие в час, контролни тестове, домашни работи, курсови разработки. Важно е да се подчертае, че тези възможности се предлагат от преподавателите. Разбира се, 68% от тях посочват като фактор:

«Студентите трябва да са мотивирани, тъй като изборът за обучение в Техническия университет е техен».

Какви са целите на обучение по математика в техническите висши училища: 95% от анкетираните посочват, че това е целенасочена подготовка за усвояване на инженерните дисциплини; 88% - развиване на умения за самостоятелна работа; 78% за развиване на логическото мислене (въпреки, че организацията на учебния процес не подкрепя тези идеи). Само 48% определят като цел «създаване на умения за работа в екип» и 58% «изграждане на интелектуални умения». Около 38% са споделили, че не се замислят за целите, а следват дадената програма.

Някои препоръки

Разнородният характер на проблемите показва, че решенията трябва да се търсят в различни посоки и засягат различни институции, имащи отношение към прехода средно училище – висше училище. Някои от възможните препоръки са: (1) установяване на активен диалог между средните и висшите училища както на институционално ниво, така и извън официалните контакти, със стриктно спазване на държавните образователни изисквания за учебно съдържание и създаване на екипи за обмяна на опит между преподаватели от университета и учители в училища с изявен интерес на учениците им към съответните технически специалности; (2) помощ в професионалното ориентиране на учениците с разясняване значението на математиката като базова дисциплина в последващото им обучение и информация за разликите в организацията на учебната дейност в средното и висшето училище; (3) изготвяне на брошури, чрез които първокурсниците да се запознаят с правата и задълженията им като студенти; (4) мерки за ясно и точно поставени цели и изисквания по време на семестъра и изпитите; (5) Създаване на *център по математика*

за поддържащо обучение, в който студентите да получават помощ и подкрепа за базовите си дисциплини; (6) осъществяване на преговор на основни теми от алгебрата и анализа в началото на учебната година; (7) организиране на редовни краткосрочни (1 – 2 седмични) курсове върху основни теми от средния курс и университетските дисциплини; (8) въвеждане на уеб – базирано обучение, насочено към изучаваните дисциплини по математика в първи курс с теория (доказателства на някои теореми) и решени разнообразни примери и упражнения; (9) снлаин упражненията да бъдат интерактивни с възможности за самопроверка; (10) студентите да разполагат с голям комплект от учебни материали на хартиен или електронен носител; предварително да се разяснява темата на всяка следваща лекция или упражнение и да се раздават материали за подготовка или преговор.

Заключение

Нъсемнено необходима е сериозна промяна в отношението на студентите към учебния процес и по-специално към изучаването на математика. В техническите университети математиката е базова и обслужваща дисциплина, но това в никакъв случай не намалява нейното значение. За да се разбират в дърбочина инженерните науки е необходимо студентите да усвояват теоретичните понятия и основните идеи от математическа гледна точка и да развиват логическото си мислене. Не може да се ползват директно формули и алгоритми без да се знае смисълът им и без да се изучават основните математически теории. Не е възможно само с изчислителни примери да се развива логическо мислене и интуиция.

Сериозна промяна се изисква и в отношението на преподавателите по математика към учебния процес. Интересът към проблемите на първокурсниците и запознаването с най-добрите

университетски практики и тяхното прилагане с нужните корекции е пътят към добрите резултати.

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ПРИЛОЖЕНИЕ: Анкета

1. Считате ли, че	(+)	(0)	(-)
1.1. Матурата е подходяща за приемане на студенти в техническит висши училища	3% (1)	18% (7)	80% (32)
1.2. Кандидат-студентският тест е сериозна бариера в техническите висши училища	30% (12)	33% (13)	38% (15)
1.3. Първата години е критична, особено за студентите, приети с нисък бал	85% (34)	13% (5)	3% (1)
2. Какво е вашето мнение:			
2.1. Чрез по-широкия прием кандидат-студентският „филтър” се измества в I курс	73% (29)	20% (8)	8% (3)
2.2. Създадени са условия студентите с по-нисък бал в I курс да подобрят подготовката си	25% (10)	28% (11)	48% (19)
2.3. Всяко висше училище се стреми да изпълни държавния план-прием и затова сваля нивото на приемния изпит	93% (37)	38% (3)	0% (0)
3. За много от студентите преходът „средно-висше училище” е труден. Причините?			
3.1. Слаба предварителна подготовка на студентите	85% (34)	15% (6)	0% (0)
3.2. Небалансирано съотношение между учебното съдържание и учебния хорариум	83% (33)	13% (5)	5% (2)
3.3. Ангажименти вън от учебните задължения и липса на мотивация за учене	63% (25)	28% (13)	5% (2)
3.4. Липса на навици за самостоятелна работа	83% (33)	15% (6)	3% (1)
3.5. Разликите в организацията на учебния процес в средното и висшето образование	70% (28)	20% (8)	10% (4)
3.6. Недостатъчна упоритост, постоянство и инициативност	58% (23)	28% (11)	15% (6)
3.7. Недостатъчно използване на модерни средства за обучение – компютри, интерастивни д ъски и др.	23% (9)	48% (19)	30% (12)
3.8. Учебният процес е добре организиран, но студентите не полагат достатъчно усилия	25% (10)	58% (23)	18% (7)
3.9. Отсъствия от лекции и упражнения	75% (30)	18% (7)	8% (3)

4. Ако проблемите на студентите в I курс са в слабата им предварителна подготовка, в какво се изразява тя:			
4.1. Частично изградена и непълна понятийна система	75% (30)	18% (7)	8% (3)
4.2. Неточно или грешно заучени понятия	40% (16)	35% (14)	25% (10)
4.3. Незнание на основни термини и неумение за ползването им	58% (23)	30% (12)	13% (5)
4.4. Лоша изчислителна техника	48% (19)	28% (11)	25% (10)
4.5. Неточно, непълно, грешно заучени алгоритми	55% (22)	35% (14)	10% (4)
4.6. Неумение да се разчита графична, аналитична или символна информация	58% (23)	35% (14)	8% (3)
4.7. Неумение за вербален израз на наличните знания	78% (31)	18% (7)	5% (2)
4.8. Хаотично изградена и неосъзната понятийна система	73% (29)	25% (10)	3% (1)
4.9. Неувереност при самостоятелна мисловна дейност	58% (23)	28% (11)	15% (6)
5. Предложения за преодоляване на трудностите			
5.1. По-високо ниво на кандидат-студентските изпити	80% (32)	10% (4)	10% (4)
5.2. Краткосрочни курсове за студенти с нисък бал	73% (29)	10% (4)	18% (7)
5.3. Съкращаване на учебния материал в някои факултети	28% (11)	25% (10)	48% (19)
5.4. Увеличаване на часовете за упражнения	95% (38)	5% (2)	0% (0)
5.5. Увеличаване на часовете за лекции	55% (22)	18% (7)	28% (11)
5.6. Въвеждане на курсова работа със защита след всеки раздел	43% (11)	18% (7)	40% (16)
5.7. Задължитлни домашни работи	55% (22)	23% (9)	23% (9)
5.8. Уводен тест преди всеки раздел	25% (10)	23% (9)	53% (21)
5.9. Задължителни консултации при сериозни пропуски	23% (9)	25% (10)	53% (21)
5.10. Въвеждане на контролни тестове след всяка тема	53% (21)	23% (9)	25% (10)
5.11. Използване на иновационни методи	48% (19)	28% (11)	25% (10)
5.12. Откриване на центрове за учебна помощ	60% (24)	13% (5)	28% (11)
5.13. Това не е проблем на преподавателя	23% (9)	28% (11)	50% (20)
5.14. За груби грешки да се отнемат точки	45% (18)	5% (2)	50% (20)
6. Какво е отношението ви към използване на:			
6.1. Интернет сайтове за самостоятелна подготовка	55% (22)	28% (11)	18% (7)
6.2. Компютърни тестове за изпити	50% (20)	18% (7)	33% (13)
6.3. Подпомагане на часовете с програмни продукти (например Derive, Maple и други)	53% (21)	30% (12)	18% (7)
6.4. Компютрно-базирано обучение за студенти с недостатъчна база знания	45% (18)	25% (10)	30% (12)
6.5. Използване на мултимедия и интерактивни			

дъски	40% (16)	40% (16)	20% (8)
6.6. Предварително предоставяне на лекциите и упражненията и дискутирането им в час	60% (24)	15% (6)	25% (10)
6.7. Качване на ликцииите и упражненията в Интернет	63% (25)	18% (7)	20% (8)
7. Съгласуване на учебни програми в различните специалности			
7.1. Физика: Векторно смятане; диференциране и интегриране на функции	64%		
7.2. Електротехника: Комплексни числа, линейни системи с две и три неизвестни; матрично смятане; диференциални уравнения от втори ред с постоянни коефициенти; диференциране и интегриране на функции	52%		
7.3. Програмиране: Комплексни числа, Булева алгебра	58%		
8. На какво основно разчитат студентите на изпита по математика:			
8.1. На лекциите и упраженията	68% (27)	20% (8)	13% (5)
8.2. На препоръчани учебници и сборници	30% (12)	43% (17)	28% (11)
8.3. На записки на колеги	50% (20)	35% (14)	15% (6)
8.4. На материали от Интернет	13% (5)	23% (9)	65% (26)
8.5. На консултации	13% (5)	38% (15)	50% (20)
8.6. На късмет	70% (28)	25% (10)	5% (2)
8.7. На частни уроци	25% (10)	50% (20)	25% (10)
8.8. На самостоятелна подготовка	38% (15)	50% (20)	13% (5)
8.9. На преписване от колега	63% (25)	33% (13)	5% (2)
8.10. На „пищови"	63% (25)	33% (13)	5% (2)
9. На какво ниво трябва да се преподава математика в техническите висши училища			
9.1. Само определения, теореми без доказателства и конкретни примери	28% (11)	23% (9)	50% (20)
9.2. Някои не особено трудни доказателства е препоръчително да се дават	85% (34)	3% (1)	13% (5)
9.3. Студентите трябва да познават различните методи на математическите доказателства	65% (26)	23% (9)	13% (5)
9.4. Доказателствата развиват логическото мислене	90% (36)	8% (3)	3% (1)
9.5. Доказателствата спомагат разбирането на разглежданите теми	72% (28)	28% (11)	3% (1)
9.6. Доказателствата обгатяват с идеи	78% (31)	23% (9)	0% (0)
9.7. Основните теореми трябва да се доказват	75% (30)	15% (6)	10% (4)
9.8. Не се интересувам къде студентите ще използват този учебен материал	10% (4)	20% (8)	70% (28)
10. За мотивацията на студентите			
10.1. Студентите трябва да са мотивирани – нали следването на дадена специалност е техен личен избор	68% (27)	30% (12)	3% (1)
10.2. Нужни са повече разяснения относно ползата от преподавания материал	78% (31)	15% (6)	8% (3)
10.3. Решаване на подбрани приложни задачи	75% (30)	18% (7)	8% (3)

10.4. Създаване на творческа атмосфера	90% (36)	8% (3)	3% (1)
10.5. Въвеждане на нови методи и средства в обучението	58% (23)	33% (13)	10% (4)
10.6. Широко използване на компютрите	43% (17)	45% (18)	13% (5)
10.7. Сериозни контролни работи и изпити	88% (35)	10% (4)	3% (1)
10.8. Крайните оценки да зависят не само от изпита, но да се вземат под внимание семестриалните контролни упражнения, участието в час, курсовата работа.	85% (34)	8% (3)	8% (3)
11. Какви са целите на математическото образование в техническите висши училища			
11.1. Развиване на логическо мислене	78% (31)	15% (6)	8% (3)
11.2. Умения за самостоятелна работа	88% (35)	10% (4)	3% (1)
11.3. Умения за работа в екип	48% (19)	28% (11)	25% (10)
11.4. Подготовка към инжнерните дисциплини	95% (38)	5% (2)	0% (0)
11.5. Изграждане на интелектуални умения	58% (23)	28% (11)	15% (6)
11.6. Не се замислям – следвам програмата	38% (15)	10% (4)	53% (21)

Положително (+); Без мнение (0); Отрицателно (-)

БЕЛЕЖКИ

1. http://www.lms.ac.uk/policy/tackling_maths_prob.pdf.

ЛИТЕРАТУРА

Банков, К. (2007a). Ефективна ли е подготвката на учители по математика в България? *Математика и информатика*, *13*(6), 3-12.

Банков, К. (2007b). Спад на ученическите постижения по математика и природни науки в България. *Образование*, кн.1, 21-32.

Димитров, А. & Тошев, Б.В. (2001). Преди да е станало късно. 1. Реформата във висшето образование. *Стратегии на образователната и научната политика*, *9*(2), 1-8.

Croft, A. (1999). A guide to the establishment of a successful mathematics learning support centre. *J. Math. Educ. Sci. & Technol.*, *31*, 431-446.

Croft, A. (2002). Innovations in engineering mathematics education in UK (p. 680-686). In.: Ivanchev, D. & Todorov, M.D. (Eds.). *Applications of mathematics in engineering and economics.* Sofia: Heron Press.

De Guzman, M., Hodgson, B., Robert, A. & Villani, V. (1998). Difficulties in the passage from secondary to tertiary education (p. 747-762). In.: Fischer, G. & Rehmann, U. (Eds.). *Proceedings of the International Congress of Mathematics. Vol. III.* Berlin: Documenta Mathematica.

Habash, R.W.Y., Suurtaam, C., Yagoub, M.C.E., Kara, K. & Ibrahim, G. (2006). Online learning resorce for smooth transition from high school to engineering education. *Turkish J. Electrical Engineering, 14,* 101-112.

Hughes-Hallett, D. (1995). Changes in the teaching of undergraduate mathematics: the role of technology (p. 1546-1550). In.: Chatterij, S.D. (Ed.). *Proceedings of the International Congress of Mathematians 1994.* Basel: Birkhauser.

Jourdan, N. Cretchley, P. & Passmore, T. (2007). Secondary-tertiary transition: what mathematics skills can and should we expect this decade? (p. 463-472). In.: Watson, J. & Beswick, K. (Eds.). *Proceedings of the 30th annual conference of the Mathematics Research Group of Australasia.* Launceston: MERGA.

Kitchen, A. (1999). The changing profile of entrants to mathematics at A-level and to mathematical subjects in higher education. *British Educ. Res. J., 25,* 57-74.

Skemp, R. (1987). *The psychology of learning mathematics.* Hillsdale: Lawrence Erlbaum Associates.

Sutherland, R. & Dewhurst, H. (1999). *Mathematics education framework for progression from 16-19 to HE.* Bristol: Graduate School of Education.

Sutherland, R. & Rozzi, S. (1995). *The changing mathematical background of undergraduate engineering, a review of the issues.* London: The Engineering Council.

FROM THE SECONDARY SCHOOL TO THE TECHNICAL UNIVERSITY, OR ONE DIFFICULT YEAR FOR THE FIRST-YEAR STUDENTS

Abstract. The transition from the secondary school to the university has been always a problem period, linked to the various changes and difficulties for the most first year students in different universities. Lack of experience of self-training and weak knowledge base and skills of the students on one hand, and the higher level of mathematics and new organization of the teaching process on the other hand, provoke serious difficulties. Some of the prospective students do not know what they really know and what they need to know. It is not clear why they should learn exactly these math topics and they do not know how to learn what they should know. The present paper attempts to clarify the key problems and their possible reasons and sources in the learning and teaching process. A set of measures is identified that would contribute to overcoming the difficulties during this transitional for the students period. The results are based on the review of foreign experience and as well as the Bulgarian one demonstrated by extensive interviews with lecturers in mathematics of three technical universities. We believe that this situation is similar (maybe with minor differences and additions) in almost all tertiary schools where mathematics is learned as a basic subject.

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THE EFFECT OF COOPERATIVE LEARNING WITH DSLM ON CONCEPTUAL UNDERSTANDING AND SCIENTIFIC REASONING AMONG FORM FOUR PHYSICS STUDENTS WITH DIFFERENT MOTIVATION LEVELS

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Abstract. The purpose of this study was to investigate the effect of Cooperative Learning with a Dual Situated Learning Model (CLDSLM) and a Dual Situated Learning Model (DSLM) on (a) conceptual understanding (CU) and (b) scientific reasoning (SR) among Form Four students. The study further investigated the effect of the CLDSLM and DSLM methods on performance in conceptual understanding and scientific reasoning among students with different motivation levels. A quasi-experimental method with the 3 x 2 Factorial Design was applied in the study. The sample consisted of 240 students in six (form four) classes selected from three different schools, i.e. two classes from each school, with students randomly selected and assigned to the treatment groups. The results showed that students in the CLDSLM group outperformed their counterparts in the DSLM group—who, in turn, significantly outperformed other students in the traditional instructional method (T) group in scientific reasoning and conceptual understanding. Also, high-

motivation (HM) students in the CLDSLM group significantly outperformed their counterparts in the T groups in conceptual understanding and scientific reasoning. Furthermore, HM students in the CLDSLM group significantly outperformed their counterparts in the DSLM group in scientific reasoning but did not significantly outperform their counterparts on conceptual understanding. Also, the DSLM instructional method has significant positive effects on highly motivated students' (a) conceptual understanding and (b) scientific reasoning. The results also showed that LM students in the CLDSLM group significantly outperformed their counterparts in the DSLM group and (T) method group in scientific reasoning and conceptual understanding. However, the low-motivation students taught via the DSLM instructional method significantly performed higher than the low-motivation students taught via the T method in scientific reasoning. Nevertheless, they did not perform significantly higher in conceptual understanding. Finally, the results showed that there were no significant interaction effects between student motivational levels and instructional methods for the scientific reasoning and conceptual understanding scores.

Keywords: conceptual understanding, scientific reasoning, cooperative learning with Dual Situated Learning Model

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Introduction

The aim of the study is to investigate the teaching of physics according to the constructivist paradigm. The teaching model chosen is based on well known theoretical frameworks from the science education and cognitive psychology theories of Piaget, Posner and Vygotsky. This study focuses on investigating the effects of using cooperative learning and a conceptual change model, the Dual Situated Learning Model (DSLM), on form four students' physics conceptual understanding and scientific reasoning. The study

also investigates the relationship between student motivation and the process of conceptual understanding. Five general motivational constructs—mastery goals, epistemological beliefs, values, self-efficacy and test anxiety—are suggested as potential mediators of the process of conceptual understanding and scientific reasoning.

Many studies have demonstrated that students of all ages suffer from an incomplete or inaccurate understanding of many scientific phenomena (Smith et al., 1985; Westbrook & Marek, 1991). These misconceptions have been shown to be pervasive, stable, and often resistant to change through classroom instruction (Osborne & Wittrock, 1983). Since the last decade, science educators have concentrated on studying misconceptions held by students. Students' ideas in science prior to formal instruction have become a major concern among researchers in science. Numerous studies on a large number of related topics have been published (Carmichael et al., 1990; Pfundt & Duit, 1991). The substantial evidence thus accumulated has indicated that students have already acquired considerable knowledge and ideas about the natural and technological world before they have enjoyed any formal instruction. More importantly, some of these intuitive conceptions are found to differ from the accepted scientific views and have been variously labeled in the science education literature as misconceptions (e.g., Helm, 1980), preconceptions (e.g., Novak, 1977), alternative conceptions (Driver & Easley, 1978) or children's science (Gilbert et al., 1982). Furthermore, these intuitive conceptions have been found to be extremely robust to change and, often, to remain intact in children and adults alike even after completion of years of formal science instructions.

Since the middle of the 1980s the investigation of students' conception at meta-levels, namely conceptions of the nature of science and views of learning (i.e., meta-cognitive conceptions) also have been given considerable attention. Research shows that students' conceptions here are also rather lim-

ited and naive. Thus, the problem of how to bring about conceptual change in learners becomes a major challenge for science educators. However, much of this research only concentrates on the cognitive construct. The issue of motivation has been either ignored or merely foreshadowed in conceptual change research. Pintrich and colleagues introduced a broader view of the learner, one in which cognitive and motivational constructs operate in interaction, to the study of knowledge restructuring. Pintrich et al. (1993a) explained how a host of specific motivational constructs could affect the process of knowledge change. The constructs addressed included mastery goals, epistemological beliefs, personal interests, values, self-efficacy, attitudes and control beliefs. This laid the groundwork for the role of these and other motivational constructs to be explored in future research.

Motivational constructs often present a doubled-edged sword in that the valence of the constructs can have a positive or negative effect on the learning outcome. This is especially important in conceptual change research to determine whether a construct acts as a facilitator or an inhibitor of change—that is, whether the impact encourages adopting a new idea or resisting it. While various theories have recognized the importance of conceptual change, little attention has been paid to the empirical study of the effect of motivational factors and cooperative learning with instructional models such as DSLM on conceptual understanding and scientific reasoning skill among physics students.

Literature review

Vygotsky (1978) believes that social interaction among students and their peers enables them to extend their knowledge. He believes that there is a hypothetical region where learning and development best take place. He identifies this region as the zone of proximal development (McLoughlin & Oliver, 1988). This zone is defined as the distance between what an individual

can accomplish during independent problem-solving and what can be accomplished with the help of an adult or a more capable member of a group. With cooperation, direction, or help, the individual is better able to solve more difficult tasks than he or she could independently be.

The belief that peer interaction may promote learning has been applied systematically under the rubric of “cooperative learning”. Cooperative learning is an instructional technique in which students work together in structured small groups in order to accomplish shared goals (Johnson & Johnson, 1989). Research indicates that cooperative learning groups seem to help all students because the best students get to “impart” their knowledge to others and the weaker students receive peer coaching (Heller et al., 1992). Furthermore, Vygotsky (1978) suggests that an active student and an active social environment cooperate to produce developmental change. The student actively explores and tries alternatives with the assistance of a more skilled partner, as in an instructor or a more capable peer.

Recent studies have argued that conceptual change in learning is often an incremental process (Duschl & Gitmoer, 1991) that may be driven by a range of hot, irrational, social, and motivational forces (Pintrich et al., 1993). According to the DSLM proposed by She (2001), students are motivated to learn science out of curiosity aroused by events that create dissonance and present a new schema for them. Therefore, the purpose of this research is to examine cooperative learning with DSLM for conceptual change and ascertain the relationship, if any, between motivational factors such as mediators and conceptual change.

The Dual Situated Learning Model (DSLM) was developed by She (2001, 2002), Institute of Education, National Chiao-Tung University Taiwan for Conceptual Change. This model is built upon well known theoretical frameworks from science education and cognitive psychology theories (Piaget, 1974; Posner et al., 1982; Steinberg & Frensch 1996; Steinberg & Clem-

ent, 1997; Rea Ramirez & Clement, 1998). This approach emphasizes students' ontological view of a concept and the attributes of that concept, with these serving as the bases for the development of dual situated learning events. Each dual situated learning event has two functions: creating dissonance with students' pre-existing knowledge and providing a new mental set with which to construct more scientific concepts. The new mental set should, as Posner et al. (1982) suggest, enable students to see the new concept as intelligible, plausible, and fruitful. The dual situated learning events can be any type of instructional activity, such as analogy, modeling, discrepant events or inquiry-based activities.

The DSLM is composed of six major stages as follows: Stage 1 - examining the attributes of the science concept. This stage provides information about which essential mental sets are needed to construct a scientific view of the concept. Stage 2 - probing students' misconceptions of the science concept, which requires probing students' beliefs concerning the science concept. Stage 3 - analyzing which mental sets students lack. This would reveal which mental sets students lack specifically for the construction of a more scientific view of the concept. Stage 4 - designing dual-situated learning events. The design of a dual-situated learning event is according to the Stage 3 results, indicating which mental sets students' lack. If two mental sets are needed to help students construct a more scientific view of the concept, it might be necessary to design at least two dual situated learning events. Stage 5 - instructing with dual-situated learning events. This emphasis gives students an opportunity to make predictions, provide explanations, confront dissonance, and construct a more scientific view of the concept. Stage 6 - instructing with challenging situated learning event. This provides an opportunity for students to apply the mental sets they have acquired to a new situation to ensure that successful conceptual change has occurred.

Studies on buoyancy and air pressure, (She, 2002) and on thermal expansion (She, 2003) with Taiwanese students found evidence of conceptual change introduced by the DSLM through classroom instruction. During the instruction with DSLM, students were not allowed to discuss the ideas with each other, and their teachers were not allowed to provide any explanation or correct the students. The results demonstrated that without any intervention from the teacher, students could still learn by themselves from a series of dual situated learning events. Solomon (1987) proposed that social factors have a significant influence on classroom learning and knowledge construction. In addition, progress in reforming children's intuitive conceptions appears to be most successful when the social milieu of the classroom becomes a platform for constructing the desired science concepts (Hennessey, 1993). It is plausible that putting this model together with cooperative learning into actual classroom teaching and taking the social factors suggested by Solomon (1987) into consideration would result in the more successful promotion of conceptual understanding and scientific reasoning among students.

Purpose of the study

In line with the "Revised Curriculum" of the Integrated Curriculum for Secondary Schools (KBSM), this study was undertaken to investigate the extent to which cooperative learning with a Dual Situated Learning Model (CLDSLM) could help to increase conceptual understanding and scientific reasoning for physics. It also examined the moderating effects of motivational level on students' physics conceptual understanding and scientific reasoning. Thus, the purpose of this study was to ascertain the extent to which the cooperative learning with Dual Situated Learning Model (CLDSLM) methods could play a role in improving Malaysian Form Four students' conceptual understanding performance and, scientific reasoning skills. Particularly, the study is conducted to investigate if there were any significant differences in

conceptual understanding and scientific reasoning levels between students taught via cooperative learning with the Dual Situated Learning Model (CLDSLM), students taught via the Dual Situated Learning Model learning alone as the instructional method (DSLM), and students taught via the traditional instructional method (T).

The study also examines the effects of the instructional methods on highly motivated and low-Motivation students' conceptual understanding performance, and scientific reasoning. This study focuses on the comparison between three different forms of learning—i.e., cooperative learning with DSLM instructional methods (CLDSLM), DSLM without cooperative learning and the traditional group method (T). All instructional strategies use heterogeneous-ability grouping but differing in participant structure, where the experimental groups use both cooperative learning with the Dual Situated Learning Model and the Dual Situated Learning Model without cooperative learning, whereas the control group and the traditional group (T) will use neither. Furthermore, the study investigates the effects of this instructional strategy on highly motivated students and low-motivation students with regard to scientific reasoning and conceptual understanding. The interactions between the instructional methods and students' scientific reasoning and conceptual understanding are also investigated.

Thus, the objectives of the study are: (1) to investigate the effect of using cooperative learning with DSLM in science teaching on students' physics (a) conceptual understanding (CU) and (b) scientific reasoning (SR); (2) to study the interaction effect of the instructional method and motivation level on physics (a) conceptual understanding (CU) and (b) scientific reasoning (SR).

Research questions

This study aims to investigate the effects of cooperative learning with DSLM and the moderating effects of motivation level on students' physics

conceptual understanding and scientific reasoning. The research questions are as follows: (i) will students taught via the Cooperative Learning with DSLM (CLDSLM) instructional method perform higher than students taught via the DSLM instructional method, and will the latter in turn perform higher than students taught via T instructional method in physics (a) conceptual understanding (CU) and (b) scientific reasoning (SR); (ii) are there interactional effects between the instructional methods and the motivational levels (highly motivated and low-motivation) in physics (a) conceptual understanding (CU), (b) scientific reasoning (SR).

Hypotheses

Based on the research questions, the following hypotheses were formulated: $H_{01:}$ There is no significant difference in the mean scores for conceptual understanding performance (CU) and scientific reasoning (SR) performance between students taught via the CLDSLM instructional method, students taught via the DSLM instructional method and students taught via the T instructional method. (Xa=Xb=Xt); $H_{02:}$ There is no interaction effect between the instructional method and the students' motivation levels (highly motivated and low-motivation) for physics conceptual understanding (CU) performance and scientific reasoning (SR) performance.

Population and sample

The population of this study was comprised of Form Four students studying at a secondary school in the East Coast of Malaysia. The student groups were comprised of an equal proportion of boys and girls from various socio-economic backgrounds; the students lived in hostels and their own homes. In order to implement this study in a naturalistic school setting, existing classes was used because this was a quasi-experimental design study. The sample consisted of 240 students in six (Form Four) classes selected from

three different schools—i.e., two classes from each school. Students in Form Four physics classes were selected in an attempt to obtain a greater number of students with formal reasoning.

The two classes were randomly selected from each school. The size of the classes was fairly similar. Three teachers were selected for the study; they were of equal experience, having been teaching the subject for more than five years. Each of them was assigned to two classes. The experimental groups for CLDSLM consisted of 2 classes (80 students) taught by one teacher, and the DSLM group consisted of 2 classes (79 students) taught by another teacher, while the traditional group also consisted of 2 classes (80 students). The sample size per group meets the statistical power criterion of 0.8 with an alpha level of 0.05 for a moderate effect size (0.5) (Hair et al., 1998). The teachers who taught the experimental groups and control group were exposed to two weeks of training on instructional methods.

A pre-test was administered to students in each school one week before instruction commenced. From the pre-test scores, those schools that had reported means scores that were not significantly different on the reasoning test were chosen; then, the students in those schools were randomly assigned to the CLDSLM, DSLM and T groups. The scores obtained from the motivational test were used to divide the samples into the groups Highly Motivated (Y1) and Low-Motivation (Y2), and the GALT and pre-CU on topic Heat test were used as for covariate measures.

Experimental conditions

The three schools were each randomly assigned to one of the following conditions: CLDSLM: Students were taught physics via the Jigsaw Cooperative Learning with Dual Situated Learning Model method (n = 80). DSLM: Students were taught physics via the Dual Situated Learning Model with no Cooperative Learning (n = 79). T (control group): Students were

taught physics via the present classroom practice (traditional method)—that is, without the Dual Situated Learning Model or Cooperative Learning methods (n = 81) (see Table 1).

Table 1. Mechanisms for the three groups

Group 1 (CLDSLM) n = 80	Group 2 (DSLM) n = 79	Group 3 (T) n = 81
Jigsaw Cooperative Learning with Dual Situated Learning Model (CLDSLM)	Dual Situated Learning Model with help from teachers. No Cooperative Learning (DSLM)	Neither Cooperative Learning nor Dual Situated Learning Model
Cooperative Learning with DSLM students worked, discussed, and interacted in groups and used DSLM	Dual Situated Learning Model students worked on the task with help from teachers during Learning Events	Without Cooperative Learning or DSLM
Used Jigsaw cooperative learning when instructing with DSLM events and completing the worksheet on learning event Used Jigsaw cooperative when presenting or during learning events	Without cooperative learning while instructing DSLM learning events and completing the tasks for learning events, but help from teachers available. Without cooperative learning while presenting Learning Events	Without Cooperative learning and Without DSLM

The three groups were different from one another in terms of the instructional method and materials used. The first experimental group, the CLDSLM group, was asked to work in assigned jigsaw cooperative learning groups at two different motivational levels; the students discussed a task with one another and interacted, completing the task using the DSLM instructional method. The second experimental group only made use of the DSLM and help from teachers during learning events without any use of cooperative group

work where any discussion between groups would be encouraged. The normal classroom sitting arrangement and interaction between members of the class was restricted. The T group was the control group in this study. The samples in the T group receive systematic intervention and interaction with the experimenter as the one being implemented in the CLDSLM and DSLM groups. In other words, this group experienced the same reactive effects of the learning material, but without the cooperative learning or the DSLM instructional methods.

Research design

This quasi-experimental study was designed to investigate the effects of cooperative learning with a Dual Situated Learning Model and of a Dual Situated Learning Model without the cooperative learning methods on physics conceptual understanding and scientific reasoning skill. The study employed a 3x2 Factorial Design. The study also employed a quasi-experimental pre-test, post-test/control group design (Tuckman, 1999). The study was designed to investigate the effects of the independent variable on the dependent variables at each of the two levels of the moderator variable. The purpose of using a factorial design was to allow the researcher to determine whether the effects of instructional methods were generalizable across all levels of motivation or whether the effects were specific only to a particular level (Gay & Airasian, 2003). The research design is illustrated in Table 2.

Table 2. Research design

Moderator Variable (Motivation)	Independent Variable (Instructional Method)		
	CLDSLM	**DSLM**	**T**
High-Motivated (Y1)	1	2	3
Low- Motivated (Y2)	4	5	6

O_1 X1 Y1 O_2 cell (1)
O_3 X2 Y1 O_4 cell (2)
O_5 X0 Y1 O_6 cell (3)
....
O_7 X1 Y2 O_8 cell (4)
O_9 X2 Y2 O_{10} cell (5)
O_{11} X0 Y2 O_{12} cell (6)

X1: CLDSLM
X2: DSLM
X0: T
Moderator Variable
Y1: Highly motivated
Y2: Low-motivation

$O_1 = O_3 = O_5 = O_7 = O_9 = O_{11} =$ Pre-test.

$O_2 = O_4 = O_6 = O_8 = O_{10} = O_{12} =$ Post-test.

The independent variable is this study was the instructional method with three categories: 1) Cooperative learning with the Dual Situated Learning Model (CLDSLM); 2) Dual Situated Learning Model (DSLM); 3) The traditional instructional method (T).

The moderator variable was the motivational level with two categories: 1) Highly Motivated (HM); 2) Low-Motivation (LM).

The dependent variables were: 1) Conceptual Understanding (CU); 2) Scientific Reasoning (SR).

The design of the present study compared three instructional methods. Two of them were the experimental group—i.e., (a) cooperative learning with the DSLM instructional method and (b) DSLM with no cooperative learning—and the control group had (c) the T traditional instructional method with

neither cooperative learning nor DSLM. Slavin (1996) recommended the use of such a research design because it enables researchers to hold constant all factors other than the ones being studied. Additionally, the factorial design allowed the researcher to investigate the effects of three different instructional methods and motivational levels on a set of dependent variables and to ascertain whether the effects of instructional method vary depending on the level of motivation.

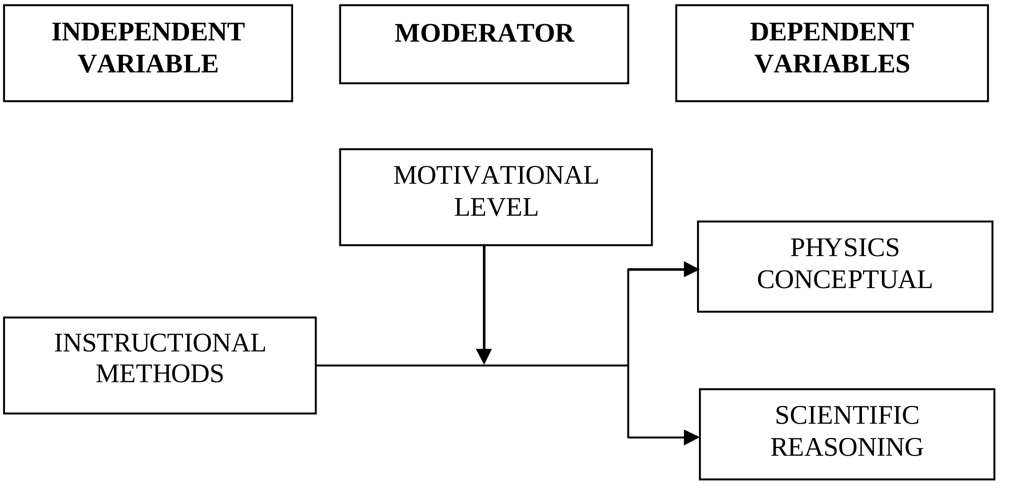

Fig. 1. Design of the study

Research variables

The independent variable for the study was the instructional method, with three categories, namely (a) cooperative learning with the dual situated learning model (CLDSLM) (b) the dual situated learning model (DSLM); and (c) traditional group work (T). The dependent variables in this study were the learners' scientific reasoning skill and conceptual understanding. Scientific reasoning skill is the quality of thought a student was capable of producing using hypothesis and deduction in his or her reasoning. Reasoning skill was

measured using Lawson's revised Classroom Test of Scientific Reasoning Skills, the CTSR (Lawsons, 1978) and Roadrangka's Group Assessment of Logical Thinking, GALT (Roadrangka et al., .1983). Roadrangka's Group Assessment of Logical Thinking was used as a pre-test and Lawson's Classroom Test of Reasoning Skill as a post-test with both the treatment and control groups.

The second dependent variable—i.e., conceptual understanding—is the degree to which what a student understands regarding a concept at a particular level corresponds with the scientifically accepted explanation of the concept. Conceptual understanding was measured using the Topic Performance Test (TPT), which has 12 items covering the task given in the context of the topic taught. This test was comprised of both objective and subjective questions. The TPT test was administered as a pre-test and post-test to each CLDSLM, DSLM and T group. Scientific reasoning skill was measured using Roadrangka's Group Assessment of Logical Thinking, GALT. To account for possible pre-existing differences in overall reasoning skill between the treatment groups, the test scores for GALT (pre-SR) and the TPT (pre-CU) were used as covariate measures.

The moderator variable was the learners' motivational level, which was designated as either Low-Motivation (LM) or Highly Motivated (HM). The Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich et al. (1993b) and translated into Bahasa Melayu by Awang-Hashim et al. (2001) was distributed before exposure to the instructional method. This instrument was used to assess the five dimensions of students' motivation with regard to learning physics. The means and standard deviations of the pre-instruction MSLQ scores for the experimental class (N=80) and control class (N=81) were analyzed.

Result

This part presents the results of the study from the data analyses of the pre-experimental study and the experimental study. The analyses were carried out using various statistical techniques, such as multivariate analysis of variance (MANOVA), univariate analysis of variance (ANOVA) and two-way multivariate analysis of covariance (MANCOVA); the two-way analysis of covariance (ANCOVA) per procedure described by Tabachnick & Fidel (2001) and Steven (1986); and post-hoc pairwise comparison using /Imatrix command analysis. A two-way multivariate analysis of covariance (MANCOVA) was conducted to analyze the effects of the instructional method on the two dependent variables and the interaction between the instructional method and the motivation level effects on the two dependent variables.

The statistical differences between the three groups were determined and analyzed according to each of the two dependent variables. The research hypotheses were tested using the results from the two-way multivariate analysis of covariance (MANCOVA) and univariate analysis of covariance (ANCOVA). The data were compiled and analyzed using Statistical Package for the Social Science (SPSS) for Windows computer software (version 11.5). The results of the analysis were used to answer Research Questions 1-4.

First, the results of the pre-experimental study in response to group's equivalence are reported. Hypotheses regarding the effects of the instructional methods on students' conceptual understanding (CU) of heat and scientific reasoning (SR) are tested and their findings presented. Then, the findings regarding the hypotheses about the effects of the instructional methods on Highly Motivated (HM) and Low-Motivation (LM) students' conceptual understanding (CU) and scientific reasoning (SR) are tested and presented. Each hypothesis tested is followed by a summary of the testing of that hypothesis. Finally, the summary of findings corresponding to the research questions is presented.

The pre-experimental study results

The aim of the pre-experimental study was to test the assumption that the samples across the three groups were equivalent in their conceptual understanding (CU) of heat and scientific reasoning. To fulfill this purpose, a pre-test that measures conceptual understanding of heat and scientific reasoning was conducted before the beginning of the study. Because there were two dependent variables, conceptual understanding of heat and pre-scientific reasoning, as well as an independent variable with three instructional groups and a moderator variable with two levels (LM and HM), two-way Multivariate analysis of variance (or two-way MANOVA) were conducted. To examine if there were significant statistical differences amongst the LM and HM students' mean scores on pre-SR and pre-CU across the three groups, two-way multivariate analysis of variance MANOVA with the splitting file technique (compare group) was conducted.

In addition, the pre-test for scientific reasoning (GALT) and conceptual understanding of heat (pre-TPT) were examined by running a reliability test to determine Cronbach alpha reliability values. The Cronbach alpha reliability coefficients of 0.62305 and 0.8214 were obtained in GALT and pre-TPT, respectively, showing that the two instruments used for this study were satisfactorily reliable.

Statistical data analysis

Table 3 summarizes the descriptive statistics for the dependent variables (pre-CU and pre-SR) by groups. The scores for Highly Motivated students' pre-CU across the three groups had relatively similar means: 10.1750, 10.7368, and 10.0476 for CLDSLM, DSLM, and T, respectively. The scores for Highly Motivated students' pre-SR also had relatively similar means: 6.5000, 6.9474, and 6.9762 for CLDSLM, DSLM, and T respectively. For

Low-Motivation students, the scores of the three groups for pre-CU were very close, (7.5500, 8.1220, and 8.2564 for CLDSLM, DSLM and T, respectively). The scores of the three groups for pre-SR were very close, (2.2750, 1.9756, and 2.4872 for CLDSLM, DSLM, and T, respectively).

Table 3. Mean and standard deviation for each dependent variable (pre-CU and pre-SR), by groups)

Group	Dependent variables Motivation High (HM) Low (LM)		Pre-CU	Pre-SR
CLDSLM	HM (n=40)	Mean	10.1750	6.5000
		SD	1.7525	.5991
	LM (n=40)	Mean	7.5500	2.2750
		SD	1.0857	1.5684
DSLM	HM (n=38)	Mean	10.7368	6.9474
		SD	2.0754	1.1377
	LM (n=41)	Mean	8.1220	1.9756
		SD	1.1289	1.4639
T	HM (n=42)	Mean	10.0476	6.9762
		SD	1.5134	1.8144
	LM (n=39)	Mean	8.2564	2.4872
		SD	1.5706	1.4346

Note. Total score for pre-CU = 22, and total score for pre-SR = 22

To examine if there were significant statistical differences between the Highly Motivated students on pre-CU and pre-SR across the three groups and if there were significant statistical differences between the Low-Motivation students on pre-CU and pre-SR across the three groups, two-way multivariate analysis of variance (MANOVA) was conducted.

Table 4 presents the results of the two-way multivariate analysis of variance, showing overall differences between highly motivated students and low-motivation students across the three groups for pre-CU and pre-SR. In the evaluation of the multivariate (MANOVA) differences, Pillai's Trace criterion was considered to have acceptable power and to be the most robust statistic against violations of assumptions (Coakes & Steed, 2001).

The MANOVA results comparing highly motivated students against highly motivated students and low-motivation students against low-motivation students across the three groups were statistically insignificant (F = 1.773, p = .135), (F = 2.255, p = .064). Further, the results of the univariate ANOVA tests (Table 4.2) indicated that there were no significant statistical differences between the highly motivated students for pre-CU and pre-SR, with F ratios (*2, 117*) of 1.653 (p = .196) and 1.700 (p =.187), respectively. Also, the results indicated that there were no significant statistical differences between the low-motivation students in pre-CU and pre-SR, with F ratios (2,117) of 2.803 (p = .65) and 1.625 (p = .201), respectively. This means that there were no statistically significant differences between highly motivated students and low-motivation students across the three groups for pre-CU and pre-SR. Therefore, the assumption that the highly motivated participants across the three groups and the low-motivation participants across the three groups are equivalent in terms of conceptual understanding and scientific reasoning was found to be correct.

Table 4. Summary of multivariate analysis of variance (MANOVA) pre-CU and pre-SR results and follow-up analysis of variance (ANOVA) results

	MANOVA Effect and Dependent Variables	Multivariate F	Univariate F df = 2,117
	Group Effect	Pillai's Trace 1.773 (*p* =.135)	
Highly Motivated (HM)	Pre-Conceptual Understanding Pre-CU		1.653 (*p*=.196)
	Pre-Scientific Reasoning Pre-SR		1.700 (*p*=.187)
	Group Effect	Pillai's Trace 2.255 (*p*=.064)	
Low-Motivation (LM)	Pre-Conceptual Understanding (pre-CU)		2.803 (*p* =.065)
	Pre-Scientific Reasoning (Pre-SR)		1.625 (*p* =.201)

The experimental study results

The purpose of the experimental study was to examine the effects of the instructional methods on conceptual understanding (CU), and scientific reasoning (SR)—specifically, on highly motivated and low-motivation students' conceptual understanding and scientific reasoning—while controlling students' pre-CU and pre-SR from the pre-test. A two-way multivariate analysis of covariance (MANCOVA) was conducted to analyze the effects of the instructional method on the two dependent variables and the interaction between the instructional methods' and the motivational levels' effects on the two dependent variables.

The statistical differences between the three groups were determined and analyzed according to each of the two dependent variables. The research

hypotheses were tested using the results of the two-way multivariate analysis of covariance (MANCOVA) and univariate analysis of covariance (ANCOVA). The results of the analysis were used to answer Research Questions 1-4.

Testing of hypothesis 1

Students taught via cooperative learning with the Dual Situated Learning Model (CLDSLM) will perform higher than students taught via the Dual Situated Learning Model (DSLM) instructional method—who, in turn, will perform higher than students taught via the traditional (T) instructional method in terms of (a) conceptual understanding (CU) and (b) scientific reasoning (SR). Thus, H_{01}: there is no significant difference in the mean scores for conceptual understanding performance (CU) and scientific reasoning (SR) performance between students taught via the CLDSLM instructional method, students taught via the DSLM instructional method and students taught via the T instructional method. (Xa=Xb=Xt).

Table 5 presents overall means, standard deviations, adjusted means, and standard errors for each dependent variable by instructional method: CLDSLM, DSLM, or T.

Table 5. Means, standard deviations, adjusted means and standard errors for each dependent variable by instructional method

Dependent Variables		Instructional Method		
		CLDSLM N = 80	DSLM N = 79	T N = 81
Conceptual Understanding	Mean	17.6500	16.5570	15.7654
(CU)	SD	2.3390	2.7351	2.2928
	Adj.mean	17742[a]	16.611[a]	15.639[a]
	Std. Error	.156	.157	.155
Scientific reasoning	Mean	15.1500	13.1646	11.7284

(SR)	SD	2.2842	2.7336	2.3875
	Adj.mean	15.289[a]	13.184[a]	11.576[a]
	Std. Error	.146	.147	.145

Note. Evaluated at covariates appeared in the model: pre-CU = 9.1417, pre-SR = 4.5250. Total score for CU = 22 and total score for SR = 22.

To examine if there were statistically significant differences in conceptual understanding and scientific reasoning, the adjusted mean scores of the CLDSLM, DSLM, and T groups were determined, while controlling the pre-CU and the pre-SR, via a multivariate analysis of covariance (MANCOVA).

Table 6 presents the results of the multivariate analysis of covariance (MANCOVA), showing overall differences based on the independent variable of the instructional method effect and the two dependent variables while controlling the pre-CU and pre-SR. The Pillai's Trace was used to evaluate the multivariate (MANCOVA) differences. The results of the MANCOVA analysis comparing the three groups were statistically significant (F = 45.575, p = .000). The covariates pre-CU (F = 14.020, p = .000) and pre-SR (F = 15.553, p = .000) had significant effects. Thus, the type of instructional method does significantly influence students' scientific reasoning (SR) and conceptual understanding (CU) of heat after a significant adjustment of group's means for the dependent variables due to differences in pre-SR and pre-CU.

Furthermore, the results of the univariate ANCOVA tests, which are presented in Table 6, indicated that there were statistically significant differences between the two dependent variables (CU, and SR). The F ratio of CU (2, 237) was 44.600 (p = .000). This means that the instructional method had a main effect on CU. This effect accounted for 28% of the variance in CU (Eta^2 = .282). The F ratio of SR (2, 237) was 161.490 (p = .000). This means that the instructional method had a main effect on SR. This effect accounted for 58% of the variance of SR (Eta^2 = .583).

Table 6. Summary of the multivariate analysis of covariance (MANCOVA) results by instructional method and follow-up analysis of variance (ANOVA) results

MANCOVA Effect, Dependent Variables And Covariate	Multivariate F Pillai's Trace	Univariate F df = 2,237
Group Effect	45.575 (p =.000)	
Conceptual Understanding (CU)		44.600 (p =.000)
Scientific Reasoning (SR)		161.490 (p =.000)
Pre-CU	14.020 (p =.000)	
Pre-SR	15.553(p =.000)	

The results of the MANCOVA analysis comparing the three groups for the two dependent variables indicated that there were statistically significant differences between two groups for the dependent variables. Therefore, the researcher further investigated the univariate statistics results (an analysis of covariance ANCOVA) by performing a post hoc pairwise comparison using the /lmatrix command for each dependent variable to identify where the differences in the adjusted means lay. Table 7 is a summary of post hoc pairwise comparisons.

Table 7. Summary of post hoc pairwise comparisons

	Dependent Variable			
Comparison Group	Conceptual Understanding (CU)	Sig	Scientific Reasoning Adj. Mean Difference	Sig
CLDSLM vs.	1.131	.000	2.105	.000

DSLM				
CLDSLM vs. T	2.103	0.000	3.713	.000
DSLM vs. T	.972	.000	1.608	.000

*Note***.** The adjusted mean differences shown in this table are the subtraction of the second condition (on the lower line) from the first condition (on the upper line); for example, 1.131 (Adjusted Mean Difference for Conceptual Understanding) = CLDSLM – DSLM.

Table 5 displays the means, standard deviations, adjusted means and standard errors of different conditions by the dependent variables. Table 6 and table 7 show that there are differences between the statistical adjusted means for the three conditions and the two dependent variables. The adjusted mean differences are presented below.

Conceptual Understanding

The cooperative learning with Dual Situated Learning Model (CLDSLM) group (Mean = 17.7, SD = 2.3, Adj.mean = 17.7, p = .000) significantly outperformed the other two groups (DSLM and T), with an adjusted mean difference of 1.131 and 2.103, respectively. On the other hand, the Dual Situated Learning Model (DSLM) group (Mean = 16.6, SD = 2.7, Adj.mean = 16.6, p = .000) significantly outperformed the control group (T) (Mean = 15.8, SD = 2.3, Adj. mean = 15.6), with an adjusted mean difference of .972. (Effect sizes on CU were .47 and .34 comparing the CLDSLM group with the DSLM group and the DSLM group with the T group, respectively).

Scientific reasoning

The CLDSLM group (Mean = 15.2, SD = 2.3, Adj.mean = 15.3, p = .000) significantly outperformed the DSLM and T groups, with adjusted mean differences of 2.105 and 3.713, respectively. The DSLM group (Mean = 13.2, SD = 2.7, Adj.mean = 13.2, p = .000) significantly outperformed the T group

(Mean = 11.7, SD = 2.4, Adj.mean = 11.6) with an adjusted mean difference of 1.608. (Effect sizes on CU were .83 and .60 for comparing the CLDSLM and DSLM, and DSLM and the T group, respectively).

Summary of testing hypothesis 1 (CLDSLM > DSLM > T)

The statistical results confirmed the hypothesis, showing that students taught via cooperative learning with the CLDSLM instructional method performed significantly better than students taught via the DSLM learning instructional method—who, in turn, performed significantly higher than the students taught via the traditional instructional method T in terms of (a) conceptual understanding and (b) scientific reasoning.

Testing of hypotheses 2

There are interaction effects between instructional methods and motivation levels (highly motivated and low-motivation) for conceptual understanding and scientific reasoning.

Table 8 presents overall means, standard deviations, adjusted means, and standard errors for the different dependent variables by the interaction between instructional methods and motivation levels (high-motivated and low-motivated).

Table 8. Means, standard deviations, adjusted means and standard errors for each dependent variable by the interaction between instructional methods and motivation levels (highly motivated and low-motivation)

Dependent Variables		Conceptual Understanding (CU)	Scientific Reasoning (SR)
Instructional Method	Motivation Highly Motivated (HM) Low-Motivation (LM)		

CLDSLM	HM (n = 40)	Mean	19.4500	16.8000
		SD	1.6939	1.8701
		Adj.mean	18.681[a]	15.745[a]
		Std.Error	.266	.249
	LM (n=40)	Mean	15.8500	13.5000
		SD	1.2517	1.2195
		Adj.mean	16.802[a]	14.833[a]
		Std.Error	.285	.267
DSLM	HM (n = 38)	Mean	19.000	15.5526
		SD	1.2945	1.4275
		Adj.mean	17.997[a]	14.155[a]
		Std.Error	.296	.277
	LM (n=41)	Mean	15.8500	10.9512
		SD	1.2517	1.4992
		Adj.mean	15.226[a]	12.213[a]
		Std.Error	.287	.269
T	HM (n = 42)	Mean	17.4286	13.6190
		SD	1.6101	1.4808
		Adj.mean	16.545[a]	12.430[a]
		Std.Error	.279	.262
	LM (n = 39)	Mean	13.9744	9.6923
		SD	1.3858	1.1955
		Adj.mean	14.734[a]	10.723[a]
		Std.Error	.269	.252

*Note***.** Evaluated at covariates appeared in the model: pre-CU = 9.1417, pre-SR = 4.5250. Total score for CU = 22 and total score for SR = 22.

To examine if the effects of instructional method on conceptual understanding and scientific reasoning depend on the motivation levels in the CLDSLM group, the DSLM group, and the T group, while controlling for pre-CU and pre-SR, a two-way multivariate analysis of covariance (MANCOVA) was conducted.

Table 9 presents the results of the two-way multivariate analysis of covariance (MANCOVA), showing overall differences in the interaction between instructional method and motivation level in their effect on the two dependent variables while controlling for pre-CU and pre-SR. Pillai's Trace was used to evaluate the multivariate (MANCOVA) differences. The MANCOVA results for the interaction effects on the two dependent variables were

statistically significant (F = 4.836, p = .000). The covariates pre-CU (F = 14.020, p = .000) and pre-SR (F = 15.553, p = .000) had significant effects. This means that there were some statistical interaction effects on at least one dependent variable across the three groups.

Furthermore, the results of the two-way univariate ANCOVA tests, which are represented in Table 9, indicated that there were statistically significant interaction effects across the three groups in SR. The F ratio of SR (2,237) was 3.401 (p = .035). This means that the interaction effect was statistically significant for students' SR. This interaction accounted for 3% of the variance in the students' SR (Eta^2 = .028). However, there were no statistically significant interaction effects across the three groups in CU. The F ratio of CU (*2*, *237*) was 2.917 ($p > .05$).

Table 9. Summary of the results of the multivariate analysis of covariance (MANCOVA) results by the interaction effect and follow-up analysis of covariance (ANCOVA) across the three groups

MANCOVA Effect, Dependent Variables, And Covariate	Multivariate F Pillai's	Univariate F Df = 2,237
Group Effect	4.836 (p =.000)	
Conceptual Understanding (CU)		2.917 (p =.056)
Scientific Reasoning (SR)		3.401 (p =.035)
Pre-CU	14.020(p =.000)	
Pre-SR	15.553 (p =.000	

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.153	5.505[a]	2.000	61.000	.006
	Wilks' Lambda	.847	5.505[a]	2.000	61.000	.006
	Hotelling's Trace	.180	5.505[a]	2.000	61.000	.006
	Roy's Largest Root	.180	5.505[a]	2.000	61.000	.006
Covariates Motivation	Pillai's Trace	.458	25.770[a]	2.000	61.000	.000
	Wilks' Lambda	.542	25.770[a]	2.000	61.000	.000
	Hotelling's Trace	.845	25.770[a]	2.000	61.000	.000
	Roy's Largest Root	.845	25.770[a]	2.000	61.000	.000

The two-way MANCOVA results regarding the interaction effects on SR indicated that there were statistically significant interaction effects between the instructional method and the students' motivation level in at least one group. Therefore, the researcher further investigated the interaction effect results by plotting the interaction between the instructional method and the students' motivation level on SR to identify where the significant interactions resided. Also, the interaction between the instructional method and the students' motivation level on CU is plotted. Fig. 2 shows the interaction effect of the instructional method and the students' motivation level across the three groups on CU.

Fig. 2 show that there is no interaction effect of the instructional method and the students' motivation level on CU across the three groups. In other words, highly motivated and low-motivation students taught via the CLDSLM, DSLM, and T instructional methods benefited equally in terms of conceptual understanding. Therefore, the effect of the instructional methods on CU did not depend on the motivation level.

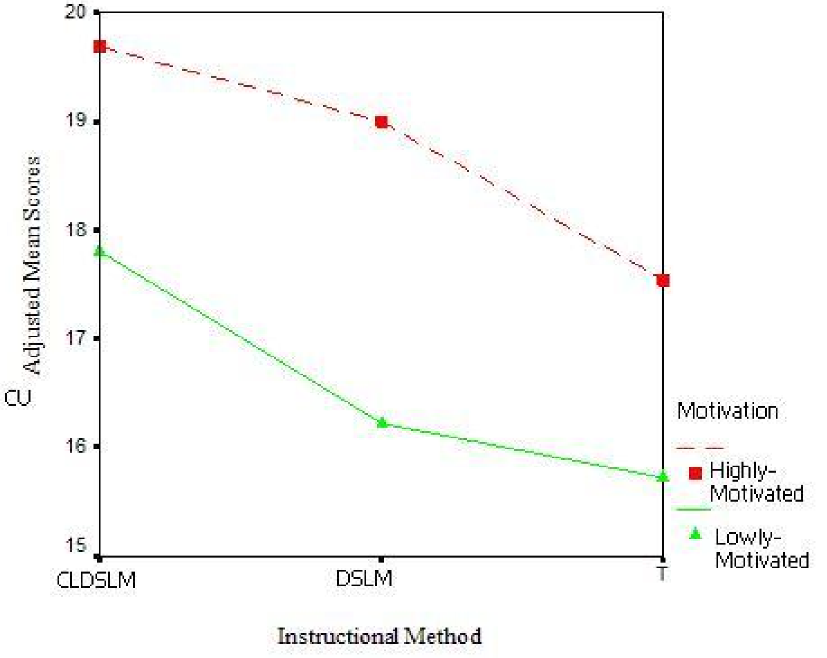

Fig. 2. Interaction effect between the instructional method and the students' motivational levels on CU

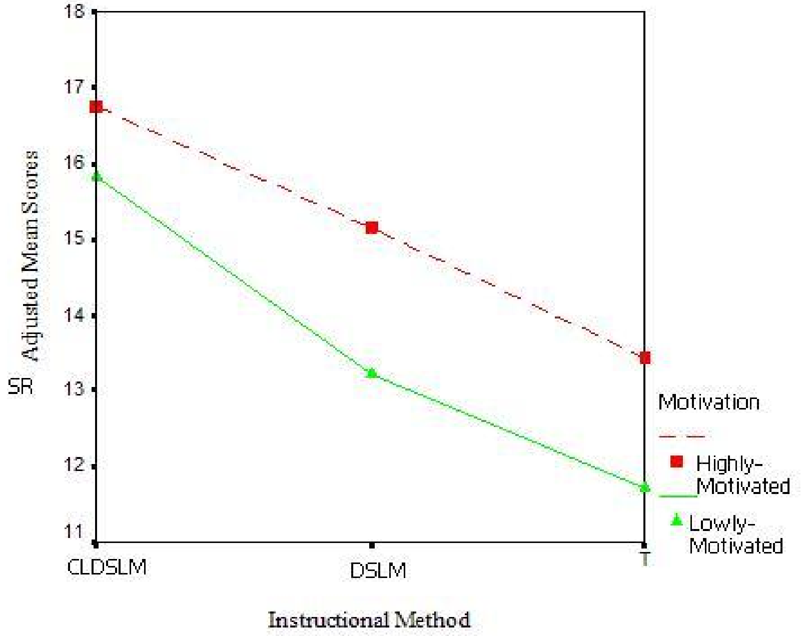

Fig. 3. Interaction effect of the instructional method and the students' motivation levels on SR

Fig. 3 shows that the low-motivation students taught via the CLDSLM instructional method benefited more than the highly motivated students taught via the same instructional method in terms of scientific reasoning. However, the figure shows that the highly motivated and low-motivation students taught via the DSLM and T instructional methods benefited equally in terms of scientific reasoning.

Summary of testing hypotheses 2

(There are interaction effects between the instructional methods and the ability levels). The statistical interaction results and the interaction figures partially confirm the hypotheses, showing that there were interaction effects between the CLDSLM instructional method and the motivational levels where low-motivation students benefited more than the highly motivated students in terms of SR but benefited equally in terms of CU. There were no interaction effects for the DSLM instructional method and the motivation level. That is, the performance of the DSLM instructional method did not depend on the motivation level. Highly motivated and low-motivation students taught via the DSLM instructional method benefited equally in terms of CU and SR. Finally, there were no interaction effects for the T instructional method and the motivational levels. That is, the performance of the T instructional method did not depend on the motivation levels. Highly motivated and low-motivation students taught via the T instructional method benefited equally in terms of CU and SR.

Summary and conclusions

This study found that the use of cooperative learning helped students to fully benefit from the Dual Situated Learning Model (DSLM). Overall, the CLDSLM group outperformed the DSLM group for all measures, showing

that for form four physics, the Dual Situated Learning Model alone was not sufficient as a form of teaching scaffolding.

The low-motivation students taught via the CLDSLM method outperformed their counterparts taught via the DSLM and T methods in conceptual understanding and scientific reasoning. The low-motivation students taught via the DSLM method in turn outperformed their counterparts taught via the T method in scientific reasoning (SR) but not in conceptual understanding (CU).

This study shows that the Dual Situated Learning Model (DSLM) learning method, when embedded with jigsaw cooperative learning scaffolding and implemented correctly in the classroom, is an effective method in helping low-motivation students learn physics with understanding and reason scientifically.

The high-motivation students taught via the CLDSLM method outperformed their counterparts taught via the DSLM method in scientific reasoning (SR) but not in conceptual understanding (CU) and outperformed their T method counterparts in CU and SR. The highly motivated students taught via the DSLM method, in turn, outperformed their counterparts taught via the T method in terms of conceptual understanding and scientific reasoning.

The CLDSLM method was highly effective in teaching conceptual understanding for both highly motivated and low-motivation students, but the interaction effects showed that the CLDSLM method is very effective for enhancing scientific reasoning among low-motivation students.

From these findings, it can be concluded that the use of cooperative learning helped the students to fully benefit from the Dual Situated Learning Model. When students are actively engaged in activities in stage 5 (that is, instructing with learning events) that emphasize giving students an opportunity to make predictions, provide explanations, confront dissonance, and construct a more scientific view of concepts, they benefit much from the Dual Situated Learning DSLM learning process. Therefore, the DSLM learning

method is inadequate without cooperative learning, or DSLM learning with the cooperative learning method is superior to the DSLM learning method alone. It follows that the DSLM learning process should be scaffolded appropriately through cooperative learning. The DSLM is especially effective in improving students' scientific reasoning. The DSLM method with cooperative learning scaffolding is effective at improving student performance in all aspects of physics. The DSLM method with cooperative learning, furthermore, is an effective method across motivation levels but is especially beneficial for low-motivation students.

REFERENCES

Awang-Hashim, R., Rahim, F.A.. & Abdullah, S.S. (2001). Confirmatory factor analysis of the Bahasa Malaysia version of the motivated strategies for learning questionnaire. *Paper presented at International Conference on Measurement and Evaluation in Education. Penang, 11th-13th November 2001*.

Carmichael, P., Watss, M. & Driver, R. (1990). *Research on students' conception in science: a bibliography*. Leeds: Children's learning in science Research group.

Coakes, J., Steed, G. (2001). *SPSS. Analysis without anguish: version 10.0 for windows*. New York: John Wiley & Sons.

Driver, R. & Easley, J. (1978). Pupil and paradigms: a review of the literature related to concept of development in adolescent science students. *Studies Science Education, 5, 61-84.*

Duschl, R.A. & Gitomer, D.H. (1991). Epistemological prospectives on conceptual change: implications for educational practice. *J. Research Science Teaching, 28,* 839-858.

Gay, L.R. & Airasian, P. (2003). *Educational research: compentecies for analysis and application.* Upper Saddle River: Pearson.

Gilbert, J., Osborne, R. & Fresham, P. (1982). Children's science and its consquences for teaching. *Science Education*, *66*, 623-633.

Hair, J.F, Anderson, R.E., Tatham, R.L., & Black, W.C. (1998). *Multirative data analysis.* Upper Saddle River: Prentice-Hall.

Heller, P. Keith R & Anderson, S. (1992). Teaching problem solving through cooperative grouping. Part 1: Group verses individual problem solving. *American J. Physics Teachers, 60,* 627-636.

Hennesey, M. G. (1993). Students' ideas about their conceptualization: their elicitation through instuction. *Paper presented at the annual meeting of the American Educational Research Association, Atlanta.*

Helm, H. (1980). Misconceptions in physics amongst South African students. *Physics Education, 15*(2), 91-97.

Johnson, D.W. & Johnson R.T. (1989). *Cooperation & competition; theory and research.* Edina: M.N. International Book.

Lawson, A.E. (1978). The development and validation of a classroom test of formal reasoning. *J. Research Science Teaching, 15,* 11-24.

Mc Loughlin, C. & Oliver, R. (1998). Maximizing the language and learning link in computer learning environment. *British J. Educational Technologies, 29,* 125-136.

Novak, J.D. (1977). An alternative to Piagetian psychology for science and mathematics education. *Science Education, 61,* 453-77.

Osborne, R. & Wittrock, M.C. (1983). Learning science: a generative process. *Science Education, 67,* 489-508.

Piaget, J. (1974). *Understanding causality.* New York: W.W. Norton.

Pintrich, P.R., Marx, R.W. & Boyle, R.A. (1993a). Beyond cold conceptual change: the role of motivational beliefs and classroom contextual

factors in the process f conceptual change. *Reviews Educational Research, 63,* 167-200.

Pintrich, P.R., Smith, D.A.F., Garcia, T. & McKeachie, W.J. (1993b). Reliability and predictive validity of the motivational strategies for learning questionnaire (MSLQ). *Educational & Psychological Measurement, 53,* 801-813.

Posner, G.J., Strike, K.A., Hewson, P.W. & Gertzog, W.A. (1982). Accommodation of a scientific conception: toward a theory of conceptual change. *Science Education, 66,* 211-227.

Pfundt, H.& Duit, R.(1991).*Bibliography:students' alternative frameworks and science education.* Kiel: University of Kiel Institute for Science Education

Rea Ramirez, M.A. & Clement, J. (1998). In search of dissonance: the evolution of dissonance in conceptual change theory. *Proceedings of National Association for Research in Science Teaching.*

Roadrangka, V., Yeany, R.H. & Padila, M.J. (1983). The construction and validation of a research group assessment of logical thinking (GALT). *Proceedings of National Association for Research in Science Teaching.*

She, H.C. (2001). Dual situated learning model: an instrumental approach towards scientific conceptual change. *Proceedings of 2001 Sino-Japanese Symposium on Science Education (Taipei, Taiwan, ROC: National Science Council).*

She, H.C. (2002). Concept of hierarchical level require more dual situated learning events for conceptual change; a study of air pressure and buoyancy, *Intern. J. Science Education, 24,* 981-996.

She, H.C. (2003). DSLM instructional approach to conceptual change involving thermal expansion. *Research Science & Technological Education, 21,* 43-54.

Slavin, R.E. (1996). Research on cooperative learning and achievement: what we need to know. *Contemporary Educational Psychology, 21,* 43-69.

Smith, C., Carey, S. & Wiser, M. (1985). On differentiation: a case study of development of the concept of size, weight, density. *Cognition, 21,* 981-996.

Solomon, J. (1987). Social influences on the construction of pupils' understanding of science. *Studies Science Education, 14,* 63-82.

Steinberg, M. & Clement, J. (1997). Constructive model evolution in the study of electric circuits. *Proceeding, the Fourth International Seminar on Misconceptions Research (Santa Cruz, CA: The Meaningful Learning Research Group).*

Stoffflett, R.T. (1994). The accommodation of science pedagogical knowledge: the application of conceptual change constructs to teacher education. *J. Research Science Teaching, 31,* 787-810.

Stevens, J. (1986). *Multivariate statistics for the social science.* Hilldale: Lawrence Erlbaum Associates.

Tavachnick, B.G. & Fidel, L.S. (1989). *Using multivariate statistics.* New York; Harper & Row.

Tuckman, B.W. (1999). *Conducting educational research.* Orlando: Harcourt Brace College Publishers.

Vygotsky, L. (1978). *Mind in society: the development of higher psychological processes.* Cambridge: Harvard University Press.

Westbrook, S.L & Marek, E.A (1991). A cross age study of student understanding of the concept of dillusion, *J. Research Science Teaching, 28,* 649-660.

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THE BEST ADDERS OF OPPORTUNITY GOVERNMENT SKILLS INITIATIVES IN THE UNITED KINGDOM

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Abstract. The focus of this paper is United Kingdom (UK) government initiatives over the last thirty years, or so, which have been designed to both up-skill the workforce and to improve the country's international competitive position. It also considers the impact which these educational interventions have had on the economic and human capital of the various stakeholders including the government, employers and learners. It comes to the conclusion that, whilst some progress has been made in developing the human capital and the economic capital of the stakeholders these interventions have not significantly improved the United Kingdom's global competitive position. The paper also points to the current political uncertainty in that country.

Keywords: human capital, economic capital, government initiatives, globalisation

Introduction

This paper considers UK government initiatives over the last thirty, or so, years which have been designed to both up-skill the workforce and to improve the UK's global competitive position. Its title is a quotation from a speech given by, the then UK education secretary, Ruth Kelly to the Association of Colleges conference in Birmingham on November 16, 2005. In that speech she suggested that

> 'the economic imperative of education, training and skills is clear and real…For most people, the best ladders of opportunity we can give them are the skills and qualifications to get a decently paid, sustainable, rewarding job.' (The Guardian 16 /11/2005).

The driving force for her was globalisation, with markets and products becoming global rather than national. Information and knowledge are increasingly important, it has been suggested that 70% of workers, in developed countries, are knowledge workers.

A variety of UK educational initiatives are identified together with the pressures, both nationally and globally, which led to their creation and implementation by successive governments. Their outcomes will also be addressed in terms of the economic and human capital of the various stakeholders including the government, employers and learners. Economic capital relates to economic resources such as cash. It consists not just of monetary income but also of accumulated wealth and the ownership of productive assets. Economic capital involves investment in resources, such as labour, to produce economic profit. Human capital involves investment in education, or training, for the production of skills and knowledge.

This paper will identify UK government strategies and initiatives and evaluate their outcomes in improving the nation's international competitiveness. .The current global economic context is one of intense competition; new

national economies have emerged to challenge and overtake those which have dominated world trade since the end of the Second World War.

'Today's world of work (in the United Kingdom) is unrecognisable from the workplace of only a few years ago' (Manpower, 2006). Changes in the world of work have been brought about by a number of factors including advances in communications, the introduction of flexible working arrangements, and greater diversity in the workplace together with the restructuring of working arrangements through both outsourcing and the transfer of work processes to other countries. There is an emerging economic structure which is both global and information driven, where economic success is increasingly reliant on the effective use of assets such as knowledge, skills and the ability to innovate. Employers now need people who have the right skills and a workforce that sufficiently is flexible to allow them to compete in a globalised economy and to maintain their human capital. As a result of which there is a perceived need for a more highly trained and educated workforce to meet he requirements of the economy in the competitive, globalised and highly technological market of the early twenty first century (Morgan-Klein & Osborne, 2007).

At the same time the structures of employment have changed and learning opportunities for employees have been under pressure to have relevance to the needs of employers to ensure the organisation's economic competitiveness and its human capital. Life long careers in one organisation are gone. During their working lives people will have to change organisations and maybe even careers in order to preserve their economic capital. Employees in the twenty first century have to be prepared to move, change and develop as employment opportunities change in order to maintain and develop their economic capital. Organisational downsizing has become 'one of the inevitable outcomes of living in a global economy where organisations are required to make continual adjustments in strategies and the cost of labour in order to re-

main competitive,’ and to manage their human and economic capita l (Carbery & Garavan, 2005). The UK government has launched a series of initiatives to attempt to address the educational and training needs which have emerged.

The strength of the UK economy has fluctuated in line with changes in global economic structures. Consequently, the structures of employment have changed in response to new working patterns of employment and international competition. Give examples, a need has also been generated for continuous updating to respond to the higher skills, which the workforce is now required to have. The focus on lifelong learning by governments is reflected in the alignment of lifelong learning with changes in the economy and workplace, the need to invest in human capital to ensure economic competitiveness in conditions of increasingly globalised capitalism (Edwards, 2001).

The European Commission and national governments’ policy statement, in relation to lifelong learning, are ‘couched almost universally in terms of ensuring greater economic competitiveness,’ Osborne & Oberski (2004). There is now a demand for learning opportunities to be relevant to the needs of the economy to ensure economic competitiveness, at an organisational and national level. There is now greater pressure on workers to expand, and increase, both their skills and knowledge.

Background

The UK, in common with many advanced nations, is now a post industrial society. This post modern economy is associated with such contemporary trends such as the growth of service-sector employment, ‘post’ industrial social formations and post Fordist models of production, work organisation and management. In the last twenty, to thirty, years there have been vast changes in the structure of employment within Britain. This was pre-empted to some extent, by the decline within the manufacturing base of the UK in the late 1970’s and the beginning of the 1980’s, with the growth in the service

sector compensating employment levels. A mass production economy did not need a well educated mass of workers, high levels of human capital, but the 'new high performance-organisations–with flatter hierarchies and team working depend upon a high level of skill and creativity throughout their workforce' (Commission on Social Justice, 1991, p.185). Projections of both work trends and the nature of employment in the twenty first century suggest that the majority of new job opportunities will be in knowledge based work, which include a range of service based activities.

The term 'knowledge economy' is used to describe this emerging economic structure which represents a departure from the economics of the twentieth century industrial era. Organisations which compete in a knowledge economy have to be able to manage, and change, to survive in an environment which is almost constantly changing The driving forces behind this change fall into several categories. They include the globalisation of markets and products, due to national and international deregulation, the increasing availability of information and communications technologies, increased networking and connectivity by way of the internet and the intensification of economic activities, which have been enabled by the growth of information technologies, products and services. Walczak (2005) argued that the international worldwide economy has evolved from an industrial manufacturing, or product, orientated economy to one which is based on knowledge and services, where the principle commodity is knowledge, or information.

Government initiatives

In common with other developed economies the UK has advocated the creation of a high skilled, high waged economy by upgrading the skills of its workforce to increase human capital. The response by governments, in the advanced states, to global changes have been, in the main, to retain central

control over the curricula, and certification of skills together with a move to manage educational achievement, or outputs, through target setting. Their motivations being to addreess demographic changes, economic development, and in some cases social justice. In this way they have sought to maintain control over education and, potentially, their competitive position in a global economy. Skills development, improving both the work related skills of the workforce and their basic numeracy and literacy skills, has been a major objective for governments in both developing and advanced nations. In the developing nations, they are seen as the key condition for economic development. For the advanced nations, education is seen as one of the principal means for maintaining high standards of living in the face of global competition, most notably from the developing countries. The Overseas Development Institute (2005) saw good quality and appropriate education as one of ‘the main drivers of competitiveness and successful participation in the globalisation process.’ Indeed Chapman & Aspin (1997) took the view that in many countries governments are concerned not only to increase their economic potential but also to make their political and social arrangements more equitable and inclusive, ‘to offer a greater range of avenues for self-improvement and personal development to all their citizens.’ In the interplay of all these three the welfare of all their citizens can best be secured and extended by increasing their human capital.

Department for innovation, universities and skills

On 28 June 2007 the UK Government created a new Department for Innovation, Universities and Skills (DIUS).The goal of this department was to deliver the Government’s espoused long-term vision which was to make the country a world leading nation for science, research and innovation. Its aim was to ensure that the UK will have the skilled workforce it needs to compete in the global economy and to develop the nation’s human capital. The Secre-

tary of State for Children, Schools and Families told Parliament that 'our task in the next decade is for our education system to become world class,' The Daily Telegraph (11/07/2007).

Only twenty three months after its formation the department was merged with the Department for Business, Enterprise and Regulatory Reform to form the Department for Business, Innovation and Skills. 'Ministers have made it clear what they think about lifelong …it is excellent – so long as it means you can do your job better,' Times Higher Education (11/6/2009) Roger Brown, Professor of higher education policy, ''This is not good news for all those who feel that policy on higher education is already drive too much by the presumed needs of business and the economy,' Times Higher Education (11/6/2009). It is believed that the set up costs for the now defunct department were in the region of £7 million.

The demise of DIUS was the latest of many UK government initiatives to up-skill the workforce and to improve the country's economic competitiveness. On 5th February 1971 the then Minister of Education, Margaret Thatcher, attended the designation service for Coventry Polytechnic, in her speech she held that the establishment of polytechnics would introduce a new dimension into higher education. Polytechnics, would, Mrs Thatcher claimed, never become universities and would improve links with industry and commerce, by way of block release which effectively linked study, training, industrial life and sponsored research and in this way they would contribute to both economic and human capital of all their stakeholders.

During the years between 1971 and 2007 there have been a variety of government initiatives which had been intended to improve the level of skills in the workforce. By 1989 little progress appeared to have been made in up-skilling the workforce. Gavyn Davies, Chief UK Economist at Goldman Sachs at that time, was quoted as saying 'a modern developed economy can only prosper if it has a labour force with skills and education to compete with the

best. Ours patently has not, The Guardian (16/6/1989). Moving forward fifteen years the same problems were still being identified. Gordon Brown (2004), the British Chancellor of the Exchequer at the time, stated that ‘if we are to succeed in a world where off-shoring can be an opportunity…our mission (is) to make the British people the best educated, most skilled, best trained in the world.’ The Leitch report (2006) summarised the position that time in this way ‘our nation’s skills are not world class and we run the risk that this will undermine the UK’s long term prosperity.’

Government training and up-skiling initiatives since 1980

In 1982 the UK government announced the Technical and Vocational Education Initiative (TVEI) which ran for over ten years. Its aims were to focus on and improve technical and vocational education for fourteen-eighteen year olds in schools and colleges, these included both planned work experience and full-time programmes which were to combine general and technical and vocational education. In 1986 the National Council for Vocational Qualifications was set up. This reflected the then government’s perception of the low level of work based skills, of human capital.. These qualifications (NVQs) were based on occupational standards of competence which were developed, endorsed by employers and were assessed in the workplace or in workplace conditions, and contributed to the human capital of employers.. In 1994 Ernst and Young found that in some sectors NVQs were not well established and that in others employers still needed to be convinced of their value to their organisation.

The Management Charter Initiative (MCI), launched in November 1987, was developed in an attempt to ensure that there were comprehensive standards for management training. The MCI sought, and still seeks, to describe and to promote common practice in management training and development by generating standards for management education and learning. These

are still recognised as a benchmark in the UK for many management qualifications. They represented a key lever in the government's attempt at producing a skills revolution in training and development, and contributed to the development of both economic and human capital for both employees and employers. In a survey of sixty one managers, who were employed in organisations which were participating in the MCI standards at that time, Reynolds & Ablett (1998) found that the most commonly cited benefits of the standards were gaining national qualifications, 89%, and improving the ability to implement changes, 76%. Thus they contributed to both economic and human capital.

In 1990, Investors in People was established as a voluntary system to encourage employers to invest in skills, or human capital, Reynolds & Ablett (1998) argued that it was intended to be a national standard, or benchmark, for the quality of training and development in organizations and was launched against a background of growing concern about a potential shortage of skills together with the need for better vocational education, and training, to improve business performance human and economic capital. In their survey of sixty organisations, which was referred to earlier in the previous paragraph, they found that the most frequently anticipated organisational benefits included improved motivation, 95%, improved employee awareness of business objectives, 95%, and a closer link between training and business goals, 80%. The benefits of using the Investors in People framework, as listed by the Cabinet Office (1999), included 'empowerment, planning and innovation' (McAdam et al, 2002).

In 1991 the UK government issued a White Paper 'Education and Training for the 21st Century' which introduced a national framework of qualifications for sixteen to eighteen year olds. In the preface to that paper Tony Blair, the prime minister at that time, wrote that 'education is the best economic policy we have' (DfEE, 1998). This national framework included

NVQs, GNVQs and ‘A’ levels. Responsibility for the less, or non-academic awards, NVQs and GNVQs, was transferred from the control of the local authorities to corporate bodies in 1993. Also in 1993 Modern Apprenticeships were introduced in Richardson (1998) opinion ‘aiming at high quality provision and suggesting that able young learners with an orientation toward the workplace needed more than NVQ programmes to stretch them’ (p. 227). In 1995 Sir Geoffrey Holland, the retired Permanent Secretary of both the Employment and Education departments, took the view that the system of post compulsory education, from sixteen to nineteen years, was not meeting its aims and in fact was, for the most part, a mess. In September of that year a report by the World Economic Forum suggested that Britain had slipped from fourteenth to eighteenth in competitiveness, this was blamed on the level of education available and on the poor motivation to train people for new jobs Segal (1995).

The 1992 Further and Higher Education Act led to the creation of the Further Education Funding Council (FEFC), the Office for Standards in Education (OfSTED), the removal of further education (FE) colleges from Local Authority control and the granting of university status to the UK’s polytechnics. The reader will recall that this was their unique selling point and that they were intended to provide an education which differed form that provided by the traditional universities.

In 2001, the FEFC and the TECs ended and the Learning and Skills Council (LSC) was created in their place. The LSC had the goal of planning, funding and securing the provision of post-sixteen education and training in The UK, excluding higher education, to help improve the UK’s skills profile and human capital. In 2001, National Training Organisations (NTOs) were replaced by the Skills for Business Network comprising Sector Skills Councils (SSCs) and the Sector Skills Development Agency (SSDA). Sector Skills Councils, through Sector Skills Agreements, were to engage employers in the

design of qualifications and training as well as identifying, and working, to tackle skills shortages and gaps, and improve both human and economic capital.

In reviewing the UK Industry and Parliament Trust's Study Group on Employability's 'Survey on Employability,' 1996/7, Andrew Clarke, Study Officer, Industry and Parliament Trust, summarised the initial findings, which were based on a survey of forty Trust member companies, which together employed over one million people, holding that a need was identified for a workforce that can adapt, communicate and work well in a team, who welcome new ideas and expect the learning process to continue for life. The responsibility for the maintenance of competence and skills to ensure that staff remain employable, and can ensure their economic capital, in the wider job market was thought to be a shared one, between both employer and employee. The UK government whitepaper, 'Building the Knowledge Economy,' Department for Trade and Industry (1998), acknowledged these changes whilst identifying others. These included the unification of European markets, the increasing strength and numbers of global competitors, shorter product cycles and the generation of new science based industries.

In 1999, the Department for Education and Skills commissioned 'The Skills Force Employer Skills Survey,' which considered the extents, causes and implications of skills deficiencies. A significant number of employers reported that they were experiencing problems in filling vacancies due to skills shortages. Generic skills, which were identified, included basic computer literacy whilst general skills included communication, team working and problem solving. It was estimated, at that time, 1999, that almost two million employees in the UK were not fully proficient in their job due to perceived gaps in their skills.

In 2002, the UK government established the Sector Skills Development Agency, which was responsible for funding, supporting and monitoring

the network of Sector Skills Councils (SSCs). The SSCs had four key goals which were to reduce skills gaps and shortages, improve productivity, business and public service performance, increase opportunities to boost the skills and productivity of everyone in the sector's workforce and to improve learning supply including apprenticeships, higher education and National Occupational Standards. This was a real commitment from government departments to resolving issues which had been identified in relation to skills levels in the workforce, and to develop human capital.

By 2005 the problems of skills shortages and global economic competition had not been addressed. In her speech to the Association of Colleges conference in Birmingham on November 16, 2005 Ruth Kelly, the then Education Secretary held that 'we are twenty fourth the OECD league table in terms of the proportion of our young people who stay on in education at age seventeen.' At that time the UK were twenty first in the OECD in terms of the proportion of our adult workforce skilled to Level 2. National productivity was 25% lower than in the United States. As Ms Kelly suggested 'just catching up is hard enough. But at the same time others are racing ahead' (The Guardian, 16/11/2005).

In an OECD review of thirty countries, the UK were ranked fifteenth for the proportion of forty five to fifty four year-olds with upper secondary education, but only twenty second out of thirty for the proportion of our twenty five to thirty four year-olds skilled to the same level. Whilst South Korea improved their upper secondary qualification rate and human capitals by 40 percentage points in the same period.' A Learning and Skills Council report, 2006, argued that there is an urgent need for upgrading and re-skiling the workforce because in most occupations the necessary skill levels will increase, whilst the need for some skills will disappear. Demographically the UK workforce is ageing and the number of young people entering work will decline from 2010, leading to increased reliance on the existing workforce.

In 2007 the Department for Education and Skills confirmed plans to raise the school leaving age in The UK by 2013. It was stated that this will not mean that pupils have to stay in the classroom or continue with academic lessons but they will have to continue to receive training. The proposals seek to tackle the problem of young people leaving education without qualifications or workplace skills. Despite repeated efforts to tackle this problem the most recent statistics for The UK showed that 11% of sixteen to eighteen year olds are still outside education, training or work, they are therefore not developing their human or economic capital.

This measure is designed to address the problem which the UK is has experienced in relation to NEETs, young people who are not in employment or education, in the United Kingdom, the classification comprises people aged between sixteen and twenty four, some sixteen year olds are still of compulsory school age. Hursch (2007) held that the UK has the highest associations between social class and educational performance the OECD, and therefore gaps between human and economic capital. While the overall educational performance of the UK is in many respects not bad by international standards, international studies have shown two particular weaknesses among UK teenagers. One is that in relation to skills and knowledge, or human capital, the effect is much greater than in most other countries. The other is that a large minority of young people in the UK have negative experiences in their late teen. Reducing the proportion of sixteen to eighteen -year-olds not in education, employment or training is a priority for the UK government as being a NEET is a major predictor of later unemployment, low income, teenage motherhood, depression and poor physical health, of both human and economic capital.

Higher education

Since the 1980s the UK government has promoted participation in higher education as a strategic of economic development. Following the Dearing Report in 1997 the government set a 50 percent participation target with the aim of offering the opportunity of higher education to all who would benefit from it, and allow the to increase their human capital. Keep & Mayhew (2004) suggested that whilst the number of graduates increased the number of traditional graduate entry jobs have not. Indeed employers are now able to recruit graduates, with higher levels of human capital, which would previously have required lower level qualifications, thereby disadvantaging those who do not obtain a first degree. Research carried out as part of the Teaching and leering Research Programme in 2008 revealed that students from materially deprived backgrounds are much less likely to participate in higher education than wealthier students.

There appears to be a dichotomy in UK government policies in that whilst the economic, and competitive, advantage generated by improved learning opportunities are acknowledged access to them has become regulated by the financial ability to participate in them.. In 1998 tuition fees of £1,000 per year were introduced for university students. In 2006 these were increased to £3,000 and are to be reviewed in 2009. In their 'Global Higher Education Rankings, Affordability and Accessibility in Comparative Perspective, Usher & Cervenan (2005) ranked the United Kingdom at thirteen and New Zealand at fourteen out of fifteen countries. This was because of the high costs of higher education together with low national incomes. That report compared countries on six different measures of affordability which, taken together, also provided a weighted overall affordability ranking. It also ranked countries in terms of the accessibility of higher education, four different accessibility indicators using the rankings to reflect the two broad concepts of higher education accessibility: the extent of participation, and the social composition of the par-

ticipants. In that part of the survey the United Kingdom, the United States, Canada, Australia, and Ireland were clustered together in the mid-to high zone of the rankings, which Usher & Cervenan (2005) held was evidence of a congruence of educational policy across areas which share a common language. The Netherlands and Finland both had high participation rates and good, or excellent, gender parity scores.

Equivalent or lower level qualifications (ELQ)

In 2007 the Secretary of State for Innovation, Universities and Skills wrote to the Chairman of the Higher Education Funding Council for The UK with details of *New Higher Education Funding Incentives 2008-11*. This letter set out the government's strategy for funding for learners studying for a qualification equivalent to, or lower than, one that they have already gained. In the main the government viewed such learners as not having a claim for public funding, and with some exceptions learners would have to finance their own studies. The money being spent on these ELQ students, £100 million would be diverted to support those who were entering higher education for the first time, or those progressing to higher qualifications. There was an espoused hope that their employers would make up some of the funding shortfall. These proposals seem privilege the young and those with employer support and. they risk reducing participation in learning.

There will be three broad categories of exemptions students training to be doctors, dentists, vets, nurses and social workers and those on PGCE courses; students studying for a foundation degree; and students who are co-funded by employers. Extra money, a targeted allocation, will be made available to protect strategically important and vulnerable subjects from the impact of the ELQ policy. Strategically important and vulnerable subjects have previously been identified as including subjects as diverse as science, Arabic and Turkish language studies and other Middle Eastern area studies,

former Soviet Union Caucasus and central Asian area studies and Islamic studies.

Although part-time students make up more than 40% of the total higher education student body, UK government policy does not taken any real cognizance of them. They do not enjoy deferral of their fees until they complete their studies and the majority of them combine study with paid employment, which is taxed. Their economic capital must be used to develop their human capital. Without the funding that ELQ students and their fees bring to an institution, some courses may cease to be viable, particularly in Further Education colleges which offer only a small number of higher education courses. Whilst those providers of higher education which have made most effort to widen participation by reaching out to mature students are more likely to be adversely impacted. Those which have been less energetic in their efforts to become more inclusive will not feel the impact so heavily. Departments of Continuing Education, offering courses carrying small credit value which are often taken by adults students as they fit into their lives will also feel the impact. Those institutions which have been the most successful in opening participation to non-traditional undergraduates which encompasses all ages and career stages will be harder-hit than those which have concentrate primarily on providing initial higher education to eighteen year old school leavers.

United Kingdom in world rankings

In the OECD survey of thirty countries, which was published in December 2007, the UK was downgraded in its world ranking in mathematics from eighth to twenty forth and from seventh to seventeenth in reading. In science the UK were ranked fourteenth, down from fourth when the last comparable UK results were published, in 2001. South Korea came top in reading, with New Zealand, Ireland, Australia and Estonia among those beating Brit-

ain. Finland was best for science and second in both reading and mathematics. Taiwan was ranked first for mathematics. Whilst the OECD took the view that Poland was one of the countries which had most improved in reading, and Mexico and Greece were held to have made significant improvements in mathematics. Other nations were increasing their human and economic capital much more effectively than the United Kingdom was.

Table 1. Key UK Government educational initiatives

Year	Key UK Government educational initiatives
1970	Creation of polytechnics from local authority colleges
1982	Technical and Vocational Education Initiative (TVEI)
1986	National Council for National Vocational Qualifications (NVQ)
1987	Management Charter Initiative (MCI)
1987	White Paper on Higher Education: Meeting the Challenge
1988	Education Reform Act- created Universities Funding Council and Polytechnics and Colleges Funding Council
1990	Investors in People (IiP)
1991	'Education and Training for the 21st Century
1992	Further and Higher Education Act Further Education Funding Council Office for Standards in Education Polytechnics became universities
1997	Dearing Report on Higher Education in the Learning Society
1999	The Skills Force Employer Skills Survey
2001	Learning Skills Council (LSC) Skills for Business Network Sector Skills Councils (SSC)
2002	Sector Skills Development Agency (SSDA)
2003	White paper on the Further of Higher Education
2005	Higher Education Act created Office of Fair Access (OFFA) and the post d Access Regulator
2006	Learning and Skills council report
2006	Department for Education and Skills (DfES) Paper Widening Participation in Higher Education: Creating opportunity, releasing potential, achieving excellence
2006	Leitch Review of Skills. Prosperity for all in the global economy-world class skills
2007	Plans announced to raise school leaving age to eighteen by 2013
2007	Equivalent or lower level qualifications (ELQ)
2007	Department for Inn ovation, Universities and Skills (DIUS) and Department for Children, Schools and Families (DCSF) replaced Department for Education and Skills (DfES)
2008	Incorporation of FE colleges and university colleges as universities providing foundation degrees
2009	

Conclusions

The prosperity of all nations depends on their skill; base, or human capital. In common with other developed, and developing, countries, the prosperity of the UK depends on its skills base. The country had advocated the creation of a high skilled economy by upgrading the skills of its citizens; it has promoted lifelong learning to ensure competitiveness and international, national and organisational levels in an attempt to achieve this. Its policies influence the human capital of organisations and individuals, together with their economic capital. There have been a number of skills initiatives launched by the UK government to attempt to address the educational and training needs which it has faced, and continues to face, some of these have been considered in this paper. The Leitch Review of Skills in the UK (2006), which was considered earlier, identified that over 70% of the UK 2020 workforce had already completed their compulsory education. That report set targets to improve the skills of the workforce, yet by May 2009 it was being reported that the UK will fail to meet the Leitch Review 's target to train at least 90% of the workforce to Level 2 by 2020, a major study by UK Commission for Employment and Skills(UKCES) to improve skills admitted. (Peacock, Personnel Today, 7/5/2009). Only 77% of UK workers will be qualified to Level 2 in by 2020 up 18% from 2005 but still at least 12% short of the target required, based on current progress levels. The report also predicted that the UK will not achieve its Level 3 target either, which specified that 68% of the UK's workforce must hold such qualifications by 2020.

The UK is in a Post Fordist sate of development where education and training are no longer viewed as an end in themselves instead they are valued as human, or economic, capital. There is an economic recession in the UK at present which has led to potential cut backs in funding for education at all levels, government, organisations and individuals. In May 2010 the UK held a

general election. The Labour party, which has been in power since 1997, was unable to form an administration. Since then the United Kingdom has had a coalition government which was formed as a result of two political parties, the Conservatives and Liberal Democrats, which appear to have a number of diametrically opposite views in relation to education working together. This new government faces a challenging economic situation, most notably a budget deficit. An emergency budget has been released which seeks to address this deficit by freezing, effectively reducing, public sector pay over a two year periods. It has yet to formally announce its detailed policies in relation to education but as all public spending is to be curtailed it is likely that spending on education, and most probably higher education, will be significantly reduced.

REFERENCES

Carberry, R. & Garavan, T.N. (2005) Organisational restructuring and downsizing issues related to learning, training and the employability of survivors. *J. Eur. Industrial Training, 29,* 488-508.

Chapman, J.D.& Aspin, D.N. (1997). *The school, the community and lifelong learning.* London: Cassell.

Commission on Social Justice (1991) Investment adding value through lifelong learning. In.: Raggart, E.R. & Small N. (Eds.) (1996) *The learning society. Challenges and trends*. London: Routledge.

Edwards R. (2001) Lifelong learning, lifelong learning, lifelong learning: a recurrent education? In.: Field, J. & Leicester, M. (2000) *Lifelong learning. Education across the lifespan*. London: Routledge.

Hursch, D. (2007). Chicken and egg: child poverty and educational inequalities, CPAG policy briefing, September 2007.

Keep, E. & Mayhew, K. (2004). The economic and distributional effects of current policies on higher education. *Oxford Review Economic Policy, 20,* 298-314.

Leitch, S. (2006). *Leitch review of skills. Prosperity for all in the global economy-world class skills.* London: HM Stationery Office.

McAdam, R., Reid, R. & Saulters, R. (2002). Sustaining quality in the UK public sector – quality measures and frameworks. *Intern. J. Quality & Reliability Managementm 19,* 581-595.

Manpower (2006) Now / Next. *A Manpower Report: The Changing World of Work.*

Morgan-Klein, B. & Osborne, M.. (2007) *The Concepts and practices of lifelong learning*. London: Routledge.

Osborne, M. & Oberski, I. (2004). University continuing education. The role of communications and information technology. *J. Eur. Industrial Training, 28,* 414-428.

Overseas Development Institute (2005) Briefing Paper, Overseas Development Institute.

Reynolds, R. & Ablett, A. (1998). Transforming the rhetoric organisational learning to the reality of the learning organization. *Learning Organization, 5,* 24-35.

Richardson, W. (1998). Work-based learning for young people: national policy, 1994-1997. *J. Vocational Education & Training, 50,* 225-249.

Segal A. (1995) Britain fails to compete with top economies, *Daily Telegraph,* 6th September, 1995.

Usher, A. & Cervenan, A. (2005). *Global higher education rankings* 2005. Toronto: Educational Policy Institute.

Walczak, S. (2005). Organizational knowledge management structure. *Learning Organizations*, *12*, 320-339.

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LITHUANIAN EDUCATION SYSTEM PROBLEMS: SENIOR CLASS STUDENTS' POSITION

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Abstract. Various changes are taking place in Lithuanian comprehensive schools in recent years. Not all of them can be considered positive and making the system's work effective. The changes taking place encourage natural interest in them. It is necessary not only to fix the current state, but to search for the ways how to optimize the changes taking place and to control them. Education is a complex, manifold phenomenon, the researches of which are complicated and complex as well. In this article Lithuanian comprehensive school senior class pupils' position on current education questions is analysed: preparation and teaching/learning process evaluation, the identification of advantages and disadvantages of education system and other. It is revealed how Lithuanian comprehensive school pupils value current education system, teacher provided knowledge quality and ability to prepare students for further studies at universities and other higher schools.

Keywords: comprehensive school, education system, evaluation, factor analysis

Introduction

In the process of intensive changes appearing in education system, it is necessary to have the more objective and full information from different sources about processes taking place in these systems that we could make adequate and timely decisions. Practically, educational researches are carried out in every country, the participants of which are senior class pupils able to present valuable information about education improvement. For example, senior class pupils' opinion research, carried out in Finland showed that pupils lack computer science knowledge; they express their great interest in studying genuine computer science (Grandell, 2005). The newest researches carried out in Sweden showed that at least one third of the students are facing serious problems with the project work (Österlind, 2010). Various researches show differences in the terms of sex. Ferreira (2004) emphasizes that teaching strategies used at the different schools should be investigated and compared to ascertain why discrepancies are encountered.

Interest in Lithuanian Education system problems is naturally understandable. On the one hand, in the process of constant changes appearing in the education system, it becomes important to know the current situation at every moment in time; on the other hand, it is important, referring to the available information, to be able to model effective changes or to carry out certain prevention measures in the case of undesirable phenomena. Over the last decade a lot of surveys were carried out in foreign countries in which students took part (Robertson, 2000; Inagaki et al., 2004; Strand, 2007). Such researches on the most various questions are carried out in many countries. Attitude researches in Lithuania have already become an inseparable part of public discourse and are rather popular. An opinion exists that surveys are not a reliable method especially that very often we can guess what the predominant answers of the respondents will be. Such presumptions usually come true. However, even if the research confirms the presumptions it is not bad, because a survey carried out in a qualified way gives a lot of new and extra information about various ana-

lysed subjects. Especially that very often in the instruments of surveys, (e.g., questionnaires) open questions are presented as well, by which much deeper information is obtained.

National school evaluation agency is carrying out a students and their parents' opinions' research on school activities.[1)] The survey is carried out electronically. Over the last decade various kinds of researches were carried out during which it was sought to ascertain opinions and attitudes to various reality phenomena. Jankauskiene & Kardelis (2002) carried out 11 class students' (girls') attitude towards their body and control of weight research. The reasons of students' unwillingness to learn were analysed in 2002. It was found that students' unwillingness to learn is determined both by inborn and acquired students' qualities, which make influence on their relations with classmates, pedagogues, form attitude to studies (Ozolaitė & Zablockytė, 2008). A research on students, teachers and parents' attitude towards education was carried out in 2002 as well (Pruskus, 2008). In 2009 a research on comprehensive school primary class pupils' attitude towards world cognition subject and educational environment was carried out (Grigorjevas & Mačiukaitė, 2009). In the research primary class pupils' having ordinary development and pupils' having special educational needs, attitude differences towards world cognition as a subject, towards educational process and educational environment were analysed. Žygaitienė (2008) carried out a research on teacher and students' attitude towards students' eloquence and its education possibilities in a comprehensive school.

Speaking about comprehensive school problems, we would like to draw attention that finishing basic education programme, forthcoming 11-formers have already to decide which subjects apart from compulsory they are going to choose in the 11^{th} form and according to their individual programme are going to learn in the 11^{th} -12^{th} form. One part of the 10^{th} formers have already been made a decision which way they will turn into after finishing school, are interested in higher school programmes, admission requirements.

The others are still wondering among their choices. The latter year secondary education concentre students experienced not a few changes which were directly connected with their educational process. Therefore, it is very important how this process is being organised, what is social environment, what level and amount material basis is in one or another education institution, what school microclimate prevails during their learning period and it is especially important what support will be provided for them from school leaders and pedagogues preparing for school leaving exams.

Thus, the research object is Lithuanian education system evaluation. The research purpose is to ascertain how Lithuanian comprehensive school students (from upper secondary level) value current education system, teacher provided knowledge quality and ability to prepare students for further studies at universities or other higher schools. The main research questions are: i) how students value their preparation in different cognition spheres; ii) how students value teaching/learning process in Lithuanian comprehensive schools; iii) what advantages and disadvantages do students discern in Lithuanian education system; iv) do students trust in present Lithuanian education system; v) what changes as necessary do students discern.

Methodology of Research

General research characteristics

The research was carried out between February and May, 2010, i.e., during the second term of the school year. The research is based on the attitude that pupils' opinion and assessment researches are important because they allow to identify urgent problems or to specify already known ones. Referring to respondent suggestion analysis, we can suggest problem solution ways, evaluate possible consequences. Opinion researches are an effective means seeking to initiate the changes.

Having covered result analysis, the interpretations made by researchers were handed to selected respondent groups (on the whole 60 respondents) for

assessment. They were asked to comment on received results. Response qualitative analysis was carried out.

Instrument

In the research the authors' prepared questionnaire was used (Lamanauskas & Railienė, 2010), which comprised open and closed questions. Respondents were asked to assess the field in which they feel the strongest/the weakest. Two open questions were presented in the questionnaire, seeking to reveal the advantages and disadvantages of Lithuanian education system referring to respondents. Also, 20 statements were presented in the questionnaire about teaching/learning in Lithuanian comprehensive schools (ranking scale was applied: 'agree', 'partly agree', 'do not agree') and they were asked to evaluate. The question about trust in our present education system was presented. The questionnaire also included a demographical part.

Research sample and geography

11 and 12 form pupils of Lithuanian comprehensive schools participated in the research. On the whole, 1150 questionnaires were acknowledged acceptable. Distribution of respondents according to forms and sex is presented in Table 1.

Table 1. Information about the respondents (N/%)

Form	**Sex**		**Total**
	Female	Male	
The 11th form	408/59.0	246/53.7	654/56.9
The 12th form	284/41.0	212/46.3	496/43.1
	692/100.0	458/100.0	1150/100.0

The participants of the research according to their geographical position were distributed as follows: Anykščiai (39, one school), Pasvalys (33, one

school), Kretinga (53, one school), Vilnius (202, three schools), Kamajai (57, one school),), Plungė (79, two schools), Šiauliai (103, three schools), Ukmergė (59, two schools), Kėdainiai district (126, three schools), Prienai (60, one school), Kaunas district (59, one school), Kėdainiai (126, three schools), Utena (49, one school), Alytus (61, two schools), other places (44). Thus, respondents from more than 25 Lithuanian comprehensive schools participated in the research. Research sample is considered sufficiently representative.

Statistical data analysis

In order to analyse research data, measures of descriptive statistics are applied (absolute and relative frequencies, popularity/significance indexes). To identify differences between variables, non parametric chi-square (χ^2) criterion is applied. Also t-test for the significance of the difference between the means of two independent samples is applied. 20 statements were evaluated applying three ranking scale. Every statement was given the calculated popularity/ significance index ($0 \leq PI/SI \leq 1$). The closer is PI value to 1, the more important, more significant is the statement to the respondent, or respondent better approves of it. A 20 statement factor analysis was carried out. The main aim of the factor analysis is to reduce the number of variables. Data, obtained on the basis of sample absolutely suit for carrying out factor analysis. Two methods were applied in order to evaluate whether the data set was appropriate for the factor analysis: Bartlett`s Test of Sphericity and Kaiser-Meyer-Olkin (KMO) test. Sample suitability for factor analysis results will be presented in Table 2.

Table 2. KMO and Bartlett's test results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.835
Bartlett's Test of Sphericity	Approx. Chi-Square	3336,265
	df	190
	Sig.	0.000

Table 2 indicates that all values are quite high (Rivera & Ganaden, 2001; Наследов, 2005). KMO test value is 0.835. Bartlett's Test of Sphericity tests the null hypothesis that the correlation matrix is an identity matrix. In this case approx. Chi-Square value is 3336.265 and p<0.000. These results clearly show that data can be used for factor analysis. A loading of 0.40 for an item to define a factor was applied based on recommendations (Ferguson & Cox, 1993). The SSPS statistics batch is used as an instrument for data processing.

Results of research

The purpose was to ascertain how the respondents value their preparation in various fields. The obtained results are presented in Table 3.

Table 3. The evaluation of the respondents' preparation (N/%)

Subject /field	The strongest preparation		The weakest preparation	
	N	%	N	%
Mathematics	204	17.7	319	27.7
Lithuanian language and literature	324	28.2	173	15.0
Natural sciences	218	19.0	162	14.1
ICT	71	6.2	87	7.6
Foreign languages	151	13.1	239	20.8
Humanitarian sciences	124	10.8	131	11.4
Arts	58	5.0	39	3.4
Total	1150	100.0	1150	100.0

In Table 3 one can see that the respondents have the strongest preparation in Lithuanian language and literature and natural sciences fields. In mathematics and foreign language fields the respondents have the weakest preparation. Generalised results do not show deeper differences that are possible, therefore, in Table 4 the results are presented according to the forms and sex of the respondents.

Table 4. Evaluation of the respondents' preparation: The strongest preparation (N/%)

Subject /field	Form		Sex		Total
	The 11th form	*The 12th form*	*Female*	*Male*	
Mathematics	117/17.9	87/17.5	108/15.6	96/21.0	204/17.7
Lithuanian language and literature	196/30.0	128/25.8	249/36.0	75/16.4	324/28.2
Natural sciences	100/15.3	118/23.8	119/17.2	99/21.6	218/19.0
ICT	51/7.8	20/4.0	23/3.3	48/10.5	71/6.2
Foreign languages	92/14.1	59/11.9	76/11.0	75/16.4	151/13.1
Humanitarian sciences	71/10.9	53/10.7	77/11.1	47/10.3	124/10.8
Arts	27/4.1	31/6.3	40/5.8	18/3.9	58/5.0
Total	654/100.0	496/100.0	692/100.0	458/100.0	1150/100.0

Analysing the obtained results according to the form you can see that differences exist. The 11th formers feel better prepared in foreign language field than 12th formers. The same can be said about Lithuanian language and literature. In the natural science field the 12th form students feel stronger than the 11th formers. It might be related with preparation for exams and further career. All these differences are statistically significant ($\chi^2 = 22.52$, df = 6, $p < 0.001$). Analysing results according to sex, we can see that girls are the strongest in Lithuanian language and literature field and boys in natural sciences and mathematics fields. The differences are also statistically significant ($\chi^2 = 75.92$, df = 6, $p < 0.000$). At least 3 times better prepared in ICT field are boys than girls.

The results are analysed how the respondents' position varies evaluating preparation according to a variable "the weakest preparation". The results are presented in Table 5.

Table 5. The evaluation of the respondents' preparation: the weakest preparation (N/%)

Subject /field	**Form**		**Total**	**Sex**		**Total**
	The 11th form	*The 12th form*		*Female*	*Male*	
Mathematics	179/27.4	140/28.2	319/27.7	196/28.3	123/26.9	319/27.7
Lithuanian language and literature	99/15.1	74/14.9	173/15.0	67/9.7	106/23.1	173/15.0
Natural sciences	101/15.4	61/12.3	162/14.1	104/15.0	58/12.7	162/14.1
ICT	44/6.7	43/8.7	87/7.6	52/7.5	35/7.6	87/7.6
Foreign languages	141/21.6	98/19.8	239/20.8	168/24.3	71/15.5	239/20.8
Humanitarian sciences	68/10.4	63/12.7	131/11.4	87/12.6	44/9.6	131/11.4
Arts	22/3.4	17/3.4	39/3.4	18/2.6	21/4.6	39/3.4
Total	654/100.0	496/100.0	1150/100.	692/100.0	458/100.	1150/100.

A statistically significant difference exists analysing the results of the respondents according to sex (χ^2 = 50.05, df = 6, p < 0.000). The majority of boys think that they have got weak preparation in mathematics and Lithuanian language and literature fields. Girls think that they are the weakest in mathematics and foreign language field. No other significant differences were established. Analyzing the results according to the form, no significant differences were noticed (p > 0.05). Both the 11th formers and the 12th formers their preparation as the weakest evaluate similarly.

Table 6. Trust in present education system (N/%)

Level	**Form**		**Sex**		**Total**
	The 11th form	*The 12th form*	*Female*	*Male*	
Trust	41/6.3	30/6.0	48/6.9	23/5.0	71/6.2
Partly trust	397/60.7	271/54.6	421/60.8	247/53.9	668/58.1
Don't trust	216/33.0	195/39.3	223/32.2	188/41.0	411/35.7
Total	654/100.0	496/100.0	692/100.0	458/100.0	1150/100.0

An interesting parameter is the trust in education system (Table 6).. Existing various and very often controversial opinions in the society about

Lithuanian education system, this information in one way or another is forming students' opinion as well.

In Table 6 we can see that only 6.2% of the respondents trust in education system. More than one third of the respondents express distrust in education system. The great majority (58.1%) only partly trust in it. Analysing the results according to the form, we can see that there are not any statistically significant differences ($\chi^2 = 4.92$, df = 2, $p < 0.085$). Thus, both the 11th formers and the 12th formers do not trust in present education system. However, statistically significant differences according to sex were identified ($\chi^2 = 9.90$, df = 2, $p < 0.007$). There are more boys more than girls who distrust education system.

There have been analysed 20 statements (Appendix 1) about teaching/learning in comprehensive schools. The results are presented in Fig. 1.

Generally speaking, respondents agree, that atmosphere is suitable for learning at schools (SI=0.66), quality of knowledge provided at schools, on the whole, is good (SI=0.65), and teachers willingly give advice to students on different topics being learnt at school (SI=0.68). However, we need to emphasize that significance indexes are comparatively not high, though bigger than 0.50. 8 of 20 statement significance indexes are lower than 0.50. Therefore, we can surely claim that learning difficulties, as a matter of fact, are not related with communication problems (SI=0.30), the size of school, practically, does not determine teaching quality (SI=0.34). Also, we can see, that schools are insufficiently interested in students' learning needs (SI=0.35), do not pay proper attention to professional orientation (SI=0.38).

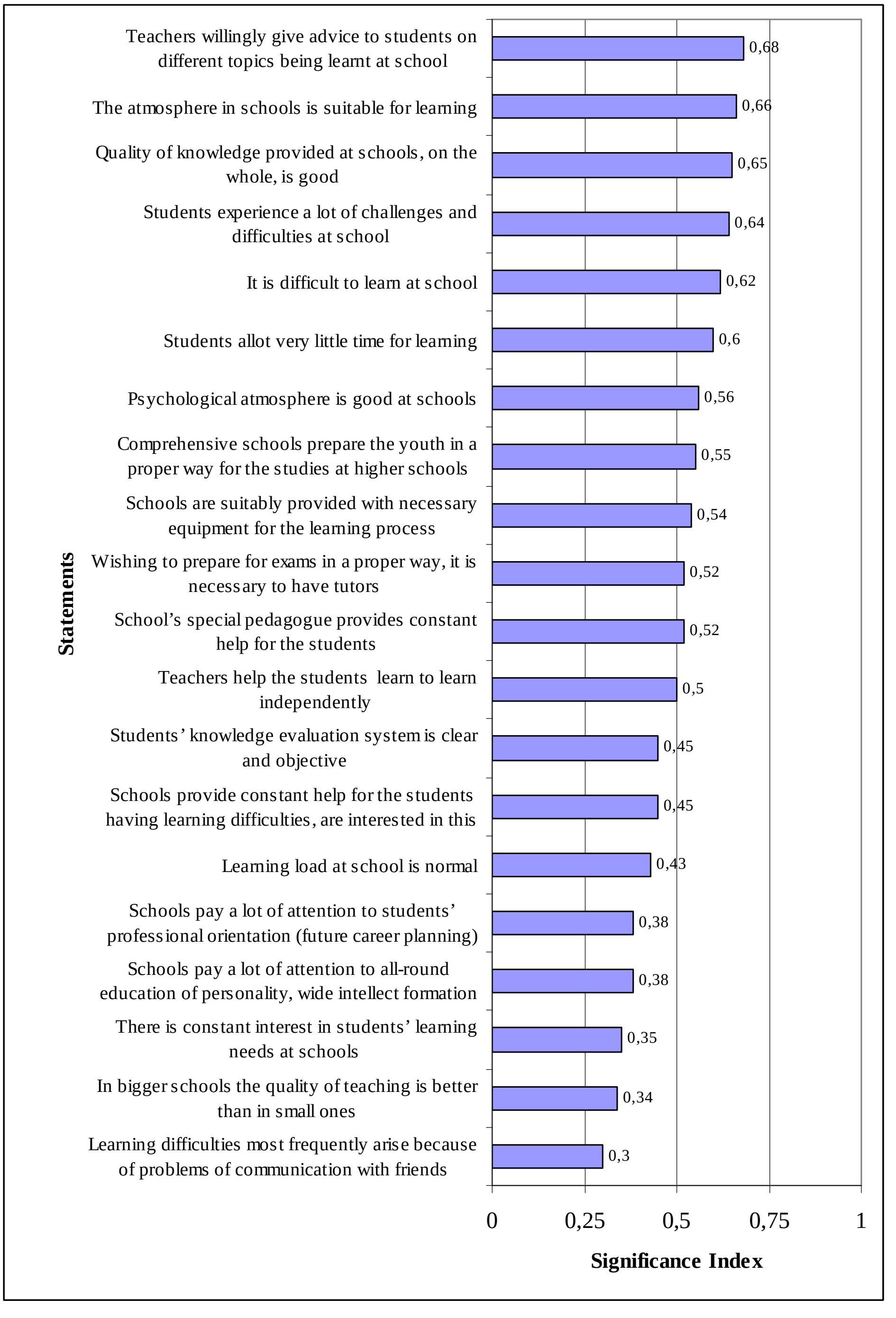

Fig. 1. Statements about teaching/learning in Lithuanian comprehensive schools (SI).

All statements were analysed from the point of view of possible statistical differences according to sex and form variables. Statistically significant differences according to forms are not identified, in all cases $p>0.05$. This shows that all statements are equally valued both by the 11th formers and the 12th formers. According to sex, statistically significant differences have already been identified by statements 1, 6, 10, 11, 12, and 16. These statements are differently evaluated by boys and girls. 2.7% of girls and 6.3 % of boys do not agree with the statement that quality of knowledge provided at schools is good, partly agree with the statement 61.7% of girls and 57 % of boys. The difference is statistically significant ($\chi^2 = 9.61$, df = 2, p = 0.008). Boys more critically value the quality of teaching than girls. 35.1 % of girls and 29.5 % of boys agree with the statement, that wishing to prepare properly for exams it is necessary to have tutors. Correspondingly, not agreeing with this statement, there are less girls than boys. The difference is statistically significant ($\chi^2 = 8.25$, df = 2, p = 0.016). Conditionally we can think that girls have bigger need for the help from outside (tutors), than boys. The respondents differently value the importance of the school size. More boys (21.8%) than girls (16.0%) agree with the statement, that in bigger schools the quality of teaching is better than in small ones ($\chi^2 = 8.19$, df = 2, p = 0.017). Boys are more critical than girls on the question of professional orientation/consultation. In general, the bigger part of the respondents think, that schools do not give sufficient attention to this activity field. 38.2% of girls and 45.6% of boys do not agree, that schools pay a lot of attention to professional orientation ($\chi^2 = 9.26$, df = 2, p = 0.010). Also, boys are more critical than girls as concerns special pedagogue's provided help for the students. 31.5% of girls do not agree with the statement, that special pedagogue gives the students constant help, whilst there are only 23.8% of boys who agree with this statement ($\chi^2 = 11.17$, df = 2, p = 0.004).

The results of factor analysis

All 20 statements' factor analysis was carried out. The five factors were extracted based on the Eigen Value Statistics (with the real value more than one). All these factors accounts for 46.68% of variance.

Table 7. Factor analysis results of the statements about teaching/learning in Lithuanian comprehensive schools

	FACTOR 1 ***The organization of teaching process***	**Factor loadings**	**SI & SD**
18.	Schools provide constant help for the students having learning difficulties, are interested in this	0.705	SI= 0.4686; SD= 0.2161
14.	There is constant interest in students' learning needs at schools	0.660	
16.	School's special pedagogue provides constant help for the students	0.643	
15.	Schools pay a lot of attention to all-round education of personality, wide intellect formation	0.595	
19.	Teachers help the students learn to learn independently	0.570	
12.	Schools pay a lot of attention to students' professional orientation (future career planning)	0.568	
20.	Teachers willingly give advice to students on different topics being learnt at school	0.512	
	FACTOR 2 ***Learning difficulties (complexity)***	**Factor loadings**	**SI and SD**
3.	It is difficult to learn at school	0.729	SI=0.5668 SD=0.1708
5.	Learning load at school is normal	- 0.708	
13.	Students experience a lot of challenges and difficulties at school	0.669	
	FACTOR 3 ***Teaching/learning atmosphere***	**Factor loadings**	**SI and SD**
8.	The atmosphere in schools is suitable for learning	0.696	SI=0.5900 SD=0.2478
9.	Psychological atmosphere is good at schools	0.668	
11.	Schools are suitably provided with necessary equipment for the learning process	0.521	
	FACTOR 4 ***Education quality***	**Factor loadings**	**SI and SD**
2.	Comprehensive schools prepare the youth in a proper way for the studies at higher schools	0.703	SI=0.5794 SD=0.1787
1.	Quality of knowledge provided at schools, on the whole, is good	0.655	
6.	Wishing to prepare for exams in a proper way, it is necessary to have tutors	- 0.571	

	FACTOR 5 *Teaching/learning peculiarities*	Factor loadings	SI and SD
17.	Learning difficulties most frequently arise because of problems of communication with friends	0.671	SI=0.4138
7.	Students allot very little time for learning	0.562	
10.	In bigger schools the quality of teaching is better than in small ones	0.454	SD=0.2207

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 9 iterations.

Looking at Table 7, it is observed that there are 7 statements under the first factor, 3 statements under the 2nd factor, 3 statements under the 3rd factor, 3 statements under the 4th factor and 3 statements under the 5th factor. The first factor forms 14.43 % of total variance, the second factor constitutes 9.00 % of total variance, the third factor forms 8.56% of total variance, the fourth factor forms 8.12 % of total variance and the fifth factor constitutes 6.55 % of total variance.

Significance index was calculated for every factor (SI). The obtained result shows that the third factor has the strongest expression (SI=0.59). We can claim, that at schools, practically, prevails good psychological atmosphere and there is a suitable learning atmosphere. Factor 4 is in the second position (SI=0.57), showing that there is proper education quality and students are being prepared in a good way. The second factor (SI=0.56) shows, that it is still difficult to learn, learning load is still big, at school students experience a lot of challenges and difficulties. Factor 5 (SI=0.41) has the weakest expression, showing that learning difficulties are not related with peers or time which students allot to learning. The first factor is rather weak as well (SI=0.46). It shows, that schools pay insufficient attention to students' learning, their career planning, increasing their independence, giving help and support while learning.

A statistically significant deviation in terms of sexes has been obtained on the first, second and fourth factors. The null hypothesis H_0 about equal av-

erages is rejected at the level of significance and makes p <0.028, p<0.028, p<0.006.

Table 8. Factor significance indexes in terms of sex

	N		**SI**		**SD**	
	Female	*Male*	*Female*	*Male*	*Female*	*Male*
Factor 1	692	458	**0.47**	0.45	0.22	0.20
Factor 2	692	458	0.55	**0.58**	0.17	0.16
Factor 3	692	458	0.59	0.58	0.24	0.25
Factor 4	692	458	**0.59**	0.56	0.17	0.18
Factor 5	692	458	0.40	0.42	0.21	0.22

The first factor "*The organization of the teaching process*" is more significant for girls than for boys (t=2.20, df=1040, p=0.028). We can think that girls get more help and support from school than boys. This can be predetermined by openness of the girls, clearer expression and formulation of speech. Besides, boys, in general, lack deeper learning abilities, their identity is lower. The second factor is more significant for boys than girls (t=2.20, df=1148, p=0.028). We can think that learning for boys is more difficult, they experience more difficulties than girls. Boys' psychological tension is often bigger; they do not tend to search for help from outside. A statistically significant deviation has been consequently identified on factor 4. Girls tend to more positively evaluate education and provided knowledge quality than boys (t=2.77, df=1148, p=0.006). No significant deviations have been noticed on factors 3 and 5.

Having discussed the obtained deviations with the selected respondent group, such results were received (Table 9).

Table 9. Summary table of the respondents' commentaries

FACTOR 1 *The organization of teaching process*	**FACTOR 2** *Learning difficulties(complexity)*	**FACTOR 4** *Education quality*
• Girls learn consequently; • Are diligent; • Responsible attitude; • Ambitiousness; • The circle of interest is wider, not only the most necessary things; • More seriously look into life perspectives and responsibly plan the future; • Boys more often relate their future with going abroad, believing in luck there; • It is more complicated for boys to get concentrated in the lesson; • Boys choose specialities which require less knowledge, but more physical strength; • Girls pay more attention and time to learning, go into the heart of the matter; • Girls are more attentive; • The majority of boys choose any speciality and later look for a profitable job; • Girls like maximum; • Girls are more dutiful and feel bigger interest in learning; • Girls think, that "not educated girl is much worse than not educated boy" • Boys have a wider job choosing spectrum (can do a job which needs more physical strength;	• Boys are more close and more often keep everything inside; • Boys miss more lessons; • Are lazy; • Are more absent-minded and can't concentrate; • Not responsible attitude to learning, like to "do away with" unfavourable situations; • Boys mature later than girls; • Boys do not withstand high learning requirements; • Not concentrated in the lessons; • It is "shame" for boys to learn well; • Not attentive, not diligent; • Because most of the pedagogues are women, for girls it is easier to please them than for boys; • Most boys' restraint does not allow them to reveal themselves; • Mostly learn one subject or two, which they like, but the others don't. • Do not trouble themselves in working with the bigger amount of informa-	• Girls care more about their future beforehand and boys tend to postpone everything to the last minute. • Girls more seriously look at everything, are more interested, concentrated and boys are absent-minded, pay less attention to studies. • Boys tend to rebel and girls react to everything more calmly. • Girls are not cleverer but they are more diligent. • Girls tend to learn more, therefore provided knowledge is more understandable to them, and they value the received knowledge. It naturally happens. • Girls are more mature. • Quicker maturing, girls understand the essence of learning and knowledge more. • Evaluating the knowledge, girls seek maximum, and for boys it is enough to know minimum. • From the majority of

• Different boys and girls' character features have quite a big influence	tion source. They limit themselves with the smaller one.	knowledge they are able to choose useful information for them.

The same information was carried out in terms of forms. According to this criterion no statistically significant deviation was established. In all cases $p > 0.05$.

Discussion

Research showed that students' evaluations differ in terms of sex. Regardless common education problems at school, both girls and boys value certain things differently. Often the researchers consider sex variable one of the most important in educational researches. The carried out research revealed quite a lot deviations in terms of sex. For example, teaching process organization is more important for girls than for boys. Research results also show that it is more difficult to learn for boys, they experience more difficulties than girls. The respondents themselves notice that boys are more reserved and usually keep everything inside, they miss more lessons and at last they are more absent-minded and so on. Of course, the other respondents oppose, claiming that sex is not a good predictor of academic skills, interests or even emotional characteristics.[2)] Girls think they are cleverer, more successful and harder working than boys from as young as four, a study has found.[3)] The differences between boys and girls' learning are identified in researches carried out in different countries: Indonesia (Deolalikar, 1993), Ghana (Lavy, 1996), Great Britain (Elwood, 2005; Strand, 2007), USA[4)] and others.

Our research also confirms this position, because girls hold, namely, such position. On standardized achievement tests, females typically surpass males in writing ability, reading achievement, and certain other verbal skills while males surpass females in science and mathematics.[5)] Our carried out research confirmed that girls are the strongest in Lithuanian language and literature

field and boys in natural sciences and mathematics field. This once again proves that despite of all similarities, girls and boys learn differently. The researchers notice that teachers usually do not understand the differences in an appropriate level (Gurian & Henley, 2002). It is interesting, that the researchers themselves very exactly confirmed statistically identified deviations and the interpretations handed by the researchers, giving their commentaries during the discussion. Thus, the essential questions – 'why do girls do better at school than boys' and 'what are the barriers to raising the attainment of boys' – require exhaustive answers. Closing the gap between boys and girls' attainment in Lithuanian school also is a very important issue not only for the future educators and scholars, but also for the politicians.

Conclusions

Generalizing research results we can claim, that: (i) Senior students emphasize equivalent partnership between a student and a teacher, which could be supported by mutual cooperation; (ii) In students' opinion, schools are insufficiently interested in students' learning needs, do not pay proper attention to professional orientation, very often students do not get help and advice when they need it; (iii) Senior class students critically value current education system, express rather big distrust of it (more than one third distrust it). Boys rather than girls distrust education system. Yearly changes, instability, not knowing about novelties and constant reforms raise reasonable worry for them; (iv) It was found, that the respondents are prepared best for Lithuanian language and literature and natural science field. The respondents are the weakest in Maths, foreign language field, though this year foreign language state exam results showed that only a very small percent of the 12th formers didn't pass foreign language exam; (v) It was stated, that girls are the strongest in Lithuanian language and literature field, and boys in natural science and Maths field. A tendency is noticed, that choosing subjects in 11-12 forms, the bigger percent of boys just choose the expanded course of sciences; (vi) It is more diffi-

cult to learn for boys, they experience more difficulties than girls. However, girls tend to evaluate education and provided knowledge quality more favourably than boys.

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NOTES

1. http://www.nmva.smm.lt/index.php?id=126
2. http://www.campbell-kibler.com/Stereo.pdf
3. http://www.guardian.co.uk/education/2010/sep/01/girls-boys-schools-gender-gap/print
4. http://www.education.gov.uk/research/data/uploadfiles/DCSF-RR002.pdf
5. http://www.eric.ed.gov/PDFS/ED423210.pdf

REFERENCES

Наследов, А. (2005). *SPSS: компьютерный анализ данных в психологии и социальных науках*. Санкт-Петербург: Питер.

Deolalikar, A.B. (1993). Gender differences in the returns to schooling and in school enrollment rates in Indonesia. *J. Human Resources, 28,* 899-932.

Elwood, J. (2005). Gender and achievement: what have exams got to do with it? *Oxford Review of Education, 31,* 373-393.

Grandell, L. (2005). High school students learning university level computer science on the web – a case study of the DASK-model. *J. Information Technology Education, 4,* 207-218.

Grigorjevas, J. & Mačiukaitė, A. (2009). Bendrojo lavinimo mokyklos pradinių klasių mokinių požiūrio į pasaulio pažinimo dalyką ir ugdomąją aplinką tyrimas. *Jaunųjų mokslininkų darbai*, Nr. 4(25), 143-149.

Gurian, M. & Henley, P. (2002). *Boys and girls learn differently: a guide for teachers and parents*. San Francisco: Jossey-Bass.

Ferreira, J.G. (2004). An exploratory survey of male and female learner opinions on secondary school biology education in Gauteng. *South African J. Education*, *24*, 105-107.

Ferguson, R.D., Cox, T. (1993). Exploratory factor analysis: a user guide. *Intern. J. Selection & Assessment*, *1*, 84-93.

Inagaki, T., Kobayashi, Y. & Nakagawa, H. (2004). Attitude survey for pupils about using cellular phones in classrooms (pp. 1059-1065). In.: Cantoni, L. & McLoughlin, C. (Eds.). *Proceedings of the World Conference on Educational Multimedia, Hypermedia and Telecommunications 2004.* Chesapeake: AACE.

Jankauskienė, R. & Kardelis, K. (2002). Vienuoliktos klasės moksleivių (merginų) požiūris į savo kūną bei svorio kontrolę. *Medicina*, *38*, 444-451.

Lamanauskas, V., Railienė, L. (2010). Aktualios Lietuvos švietimo sistemos problemos: vyresniųjų klasių moksleivių pozicija. *Švietimas: politika, vadyba, kokybė*, Nr. 2(5), 39-49.

Lavy, V. (1996). School supply constraints and children's educational outcomes in rural Ghana. *J. Development Economics*, *51*, 291-314.

Österlind, E. (2010). Students' approaches to project work: self-regulated learning in Swedish upper secondary school. *US-China Education Review*, *7*(2), 16-27.

Ozolaitė, V., Zablockytė, E. (2008). Nenoro mokytis priežastys: ugdytojų ir ugdytinių požiūris. *Jaunųjų mokslininkų darbai*, Nr. 2 (18), 176-179.

Pruskus, V. (2008). Išsilavinimas kaip vertybė: mokinių, mokytojų ir tėvų požiūris. *Santalka. Filologija. Edukologija, 16*(4), 68-77.

Strand, S. (2007). Surveying the views of pupils attending supplementary schools in England. *Educational Research, 49*, 1-19.

Robertson, J.W. (2000). Do they know who they are? A survey of informed opinion on the identity foundation of Scotland's schoolchildren. *Citizenship, Social & Economics Education, 4*, 183-191.

Žygaitienė B. (2008). Mokytojų ir mokinių požiūris į mokinių iškalbą bei jos ugdymo galimybes bendrojo lavinimo mokykloje. *Pedagogika, 92*, 24-30.

APPENDIX

Statements about teaching/learning in Lithuanian comprehensive schools (N/% and SI)

Statements	**Agree**	**Partly agree**	**Do not agree**	**SI**
20. Teachers willingly give advice to students on different topics being learnt at school	519/45.1	539/46.9	92/8.0	0.68
8. The atmosphere in schools is suitable for learning	485/42.2	557/48.4	108/9.4	0.66
1. Quality of knowledge provided at schools, on the whole, is good	414/36.0	688/59.8	48/4.2	0.65
13. Students experience a lot of challenges and difficulties at school	444/38.6	585/50.9	121/10.5	0.64
3. It is difficult to learn at school	440/38.3	556/48.3	154/13.4	0.62
7. Students allot very little time for learning	408/35.5	572/49.7	170/14.8	0.60
9. Psychological atmosphere is good at schools	353/30.7	584/50.8	213/18.5	0.56
2. Comprehensive schools prepare the youth in a proper way for the studies at higher schools	273/23.7	738/64.2	139/12.1	0.55
11. Schools are suitably provided with necessary equipment for the learning process	337/29.3	580/50.4	233/20.3	0.54
6. Wishing to prepare for exams in a proper way, it is necessary to have tu-	378/32.9	442/38.4	330/28.7	0.52

tors				
16. School's special pedagogue provides constant help for the students	327/28.4	535/46.5	288/25.0	0.52
19. Teachers help the students learn to learn independently	272/23.7	605/52.6	273/23.7	0.50
4. Students' knowledge evaluation system is clear and objective	182/15.8	687/59.7	281/24.4	0.45
18. Schools provide constant help for the students having learning difficulties, are interested in this	217/18.9	611/53.1	322/28.0	0,45
5. Learning load at school is normal	250/21.7	502/43.7	398/34.6	0.43
12. Schools pay a lot of attention to students' professional orientation (future career planning)	215/18.7	462/40.2	473/41.1	0.38
15. Schools pay a lot of attention to all-round education of personality, wide intellect formation	138/12.0	605/52.6	407/35.4	0.38
14. There is constant interest in students' learning needs at schools	134/11.7	543/47.2	473/41.1	0.35
10. In bigger schools the quality of teaching is better than in small ones	211/18.3	361/31.4	578/50.3	0.34
17. Learning difficulties most frequently arise because of problems of communication with friends	121/10.5	442/38.4	587/51.0	0.30

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